Lower Passaic River Restoration Project

Field Sampling Plan
Volume 1

January 2006

Version 2006/01/11

PREPARED BY:
Malcolm Pirnie, Inc.
104 Corporate Park Drive
White Plains, NY 10602

FOR:
US Environmental Protection Agency
Region II

US Army Corps of Engineers
Kansas City District
Contract No.
DACW41-02-D-0003

FIELD SAMPLING PLAN, VOLUME 1

LOWER PASSAIC RIVER RESTORATION PROJECT

Prepared by:

Malcolm Pirnie, Inc., in conjunction with Battelle and HydroQual, Inc.

January 2006

Version: 2006/01/11

LOWER PASSAIC RIVER RESTORATION PROJECT
FIELD SAMPLING PLAN, VOLUME 1

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

1.0 INTRODUCTION

The Field Sampling Plan (FSP) presents the technical approach for conducting site characterization activities for the Lower Passaic River Study Area. Volume 1 (this document) addresses the following sampling programs:

- Geotechnical Sediment Coring.
- Sediment Transport Studies.
- High Resolution Sediment Coring.
- Low Resolution Sediment Coring.
- Tidal Water Column Monitoring.
- Tributary Water Column Monitoring
- Porewater and Groundwater Sampling.
- Mudflat Sediment Sampling.

FSP Volume 1 was developed to collect environmental sediment and water column data to support the Data Quality Objectives (DQOs) provided in Attachment 1 to the Quality Assurance Project Plan [QAPP (Malcolm Pirnie, Inc., 2005a)], which include Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Water Resources Development Act (WRDA), and Natural Resource Damage Assessment (NRDA) objectives. The collected data will include:

- Information about contaminant sources, contaminated media, and geochemical data to characterize the nature and extent of contamination.
- Information about hydrodynamic, sediment transport and stability, and biotic processes to assess the fate and transport of contaminants in sediments, water, and biota.
- Description of exposure pathways and receptors to evaluate human health/ecological risks.

To date, numerous investigations, including environmental sampling, have been conducted in parts of the Lower Passaic River by various entities having differing objectives. Therefore, available information is being compiled and evaluated in preparation for the FSP Volume 1 activities, as summarized in Section 3.0 of this document. The content of each volume of the FSP is described below:

Volume 1: FSP Volume 1 (this document) includes investigations to characterize sediment and surface water quality in the Passaic River and in major tributaries. These investigations are being done to gain chemical and physical data necessary to evaluate the spatial extent of contamination, to prepare human and ecological health risk assessments, and to understand the fate and transport of contamination within the system (including measurements of hydrodynamic and sediment transport characteristics of the Lower Passaic River and major tributaries). To this end, Hydrodynamic, Sediment Transport, Fate and Transport, and Bioaccumulation Models will be developed and calibrated based on the collected data.

Volume 2: FSP Volume 2 (Malcolm Pirnie, Inc., in 2006) will include investigations that relate to the biota and ecological aspects of the Lower Passaic River and the surrounding watershed. Investigations are to include taking inventory and cataloging the species found within and around the Lower Passaic River and obtaining tissue samples to determine potential contaminant concentrations.

Volume 3: FSP Volume 3 (Malcolm Pirnie, Inc., 2005b) includes additional investigations on candidate restoration sites, upland areas, and wetland areas in the Study Area. FSP Volume 3 also includes the 17-mile bathymetric survey of the Lower Passaic River conducted in 2004 (USACE, 2004) and the geophysical surveys conducted in the spring of 2005.

The tasks implemented under FSP Volume 1 span multiple years. Some activities have been completed and are being used to guide current and future studies; some activities are developed and scheduled for implementation; and some are under development and planned for the future. Section 3.0 below describes the status of each FSP Volume 1 task.

1.1. SITE BACKGROUND

The U.S. Environmental Protection Agency (USEPA), New Jersey Department of Environmental Protection (NJDEP), the U.S. Army Corps of Engineers (USACE), the New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR), and the Trustees for Natural Resources have partnered to conduct a comprehensive study of the Lower Passaic River. The Study Area encompasses the 17-mile tidal reach of the Passaic River below the Dundee Dam, its tributaries (*e.g.*, Saddle River, Second River, and Third River), and the surrounding watershed that hydrologically drains below the Dundee Dam [refer to the Work Plan for a site location map (Malcolm Pirnie, Inc., 2005c)]. The Lower Passaic River Restoration Project (the project) is an integrated, joint effort among state and federal agencies that will take a comprehensive look at the problems within the Study Area and identify remediation and restoration options to address those problems. This multi-year study will provide opportunities for input from the public at all phases of development. The project's goals are to provide a plan to:

- Remediate contamination found in the river to reduce human health and ecological risks.
- Improve the water quality of the river.
- Improve and/or create aquatic habitat.
- Reduce the contaminant loading in the Passaic and the New York/New Jersey Harbor Estuary.

USEPA initiated work on the project using funds from the federal Superfund program. USEPA has also signed an agreement with over 30 companies (Cooperating Parties) for them to fund the Superfund portion of the joint Study. Congress provided the USACE-New York District with funds for the WRDA study elements in the annual

Energy and Water Development Appropriations Act. NJDOT-OMR is utilizing the funds from the New York/New Jersey Joint Dredging Plan and the Transportation Trust Fund to fulfill its contribution as local sponsor. As part of the study, the partnership will examine the best authorities to implement and fund the recommendations.

1.2. CONCEPTUAL SITE MODEL

An initial conceptual site model (CSM) and methods to update the CSM were developed to examine the assumed sources of contaminants, routes of environmental transport, contaminated media, routes of exposure, and receptors. The CSM is presented in Attachment A of the Work Plan (Malcolm Pirnie, Inc., 2005c). Data gathered during the activities programmed in this FSP will be used to update the CSM, ultimately providing the basis to adapt and adjust field data collection. Additional geochemical and sediment stability analyses are currently being conducted to update the CSM and to provide guidance in determining future sampling locations for the sediment field programs described in this FSP. These geochemical and sediment analyses are listed below:

- Evaluation of historic changes in bathymetry.
- Evaluation of depositional record via radionuclide dating.
- Evaluation of historic sediment contaminant and physical properties data.

1.3. CANDIDATE RESTORATION SITES

The field sampling activities discussed in FSP Volume 2 and Volume 3 are designed to characterize the main stem of the Passaic River, its tributaries, and candidate restoration sites as well as upland and wetland areas. Some of the programs in FSP Volume 1 may be extended to support this characterization and co-located to provide information specific to candidate restoration sites. The process for selecting candidate restoration sites is outlined in the *Restoration Opportunities Report* (TAMS/Earth Tech, Inc. and Malcolm Pirnie, Inc., 2005). The candidate restoration sites include:

- Subtidal, intertidal, and riparian sites in the Lower Passaic River and along the river. These sites represent marine, brackish, and freshwater habitats.
- Large contiguous sites adjacent to the Lower Passaic River, including Oak Island Yards in Newark, New Jersey, and Kearny Point in Kearny, New Jersey.
- Main tributaries, including Second River, Third River, and Saddle River.
- Other areas in the watershed.

2.0 GENERAL FIELD REQUIREMENTS

2.1. MOBILIZATION/DEMOBILIZATION

Mobilization and demobilization procedures for field work are currently in progress at the field office site at the Kelway Industrial Park in East Rutherford, New Jersey. The following major activities have been conducted or are currently underway:

- Permitting, construction, and installation of a floating dock facility.
- Completion of a pre-occupancy surface sweep and wipe sample survey.
- Acquisition and launch of a field support vessel.
- Installation of an investigation-derived waste (IDW) storage facility.
- Installation of the lab benches, work stations, and equipment to be used to process sediment cores and manage sediment and aqueous samples.
- Installation of office, computer, and telephone equipment.

2.2. SITE FACILITIES

The field office/sample processing facility, staging areas and sampling/survey vessel floating dock are located at the Kelway Industrial Park in East Rutherford. This space is an 8,700 square-foot facility that contains a 7,200 square-foot open warehouse with 20-foot ceilings, two roll-up loading dock doors, and an office area that is approximately 1,500 square feet. The space is located about 200 yards from the east bank of the Passaic River at approximately river mile (RM) 13.5.

The company that owns the industrial park has riparian rights and is responsible for maintaining the bulkhead along the Passaic River. The owner (the Lessor) of the industrial park has included, in writing, a provision in the lease giving Malcolm Pirnie, Inc. (the Lessee) permission to install a floating dock against the bulkhead.

The USEPA, USACE-New York District, and NJDOT-OMR have agreed that leasing this facility is acceptable to their respective agencies. Finalization of permitting issues for the installation of a floating dock on the Passaic River, through the NJDEP, is complete.

2.3. HEALTH AND SAFETY

All FSP field tasks will be conducted in accordance with the site-specific Health and Safety Plan (HASP; Malcolm Pirnie, Inc., 2005d) and addenda, prepared in accordance with the Occupational Safety and Health Administration (OSHA) requirements contained in 29 Code of Federal Regulations (CFR) 1910 including the final rule contained in 29 CFR 1910.120. The procedures are also consistent with the guidance contained in the following documents:

- OSHA Guidance Manual for Hazardous Waste Site Activities [prepared jointly by the USEPA, National Institute for Occupational Safety and Health (NIOSH), OSHA, and the U.S. Coast Guard (USCG)];
- USACE's Safety and Health Requirements Manual, Engineering Manual (EM) 385-1-1 (USACE, 2003).

2.4. EQUIPMENT DECONTAMINATION

A description of equipment decontamination facilities and sequential decontamination procedures for non-dedicated equipment is provided as Standard Operating Procedures (SOPs) 6 and 7 in Attachment 1 to this volume of the FSP.

2.5. SAMPLE MANAGEMENT AND PRESERVATION

Since USEPA Contract Laboratory Program (CLP) laboratories are to be used for certain sample analysis, sample management will comply with Contract Laboratory Program Guidance for Field Samplers (USEPA 2004). As such, sample management will follow the SOP 1 Procedure to Conduct Sample Management for CLP and non-CLP Samples attached to the QAPP (Malcolm Pirnie, Inc., 2005a). Samples collected will be preserved following SOP 2 Procedures to Conduct Sample Preservation, also attached to the QAPP (Malcolm Pirnie, Inc., 2005a), to assure sample integrity when the samples are analyzed in the laboratory.

2.6. STANDARD OPERATING PROCEDURES

SOPs are provided in Attachment 1. The following SOPs are included [note SOP's 1-3 can be found in the QAPP (Malcolm Pirnie, Inc., 2005a)]:

- SOP 4: Locating Sample Points Using a Global Positioning System (GPS)
- SOP 5: Documenting Field Activities
- SOP 6: Decontamination of Soil Sampling Equipment
- SOP 7: Decontamination of Water Sampling Equipment
- SOP 8: Sediment Probing
- SOP 9: Vibracoring – Collecting High and Low Resolution Cores
- SOP 10: Split Spoon Sample Collection
- SOP 11: Core Processing – High Resolution
- SOP 12: Core Processing – Low Resolution
- SOP 13: Sediment Collection Using Hand Coring Devices
- SOP 14: X-radiograph Procedures – (to be added)
- SOP 15: Density Profiler Procedures – (to be added)
- SOP 16: Infiltrex 300 Trace Organic Sampling
- SOP 17: Deployment and Retrieval of Semipermeable Membrane Devices
- SOP 18: Small Volume Grab Water Samples and Cross-sectional Composite Sample Procedure
- SOP 19: 5-liter Niskin Bottle Use
- SOP 20: Ultra-clean Water Sampling Procedures for Mercury
- SOP 21: Horiba Use for Measuring Water Parameters
- SOP 22: Management and Disposal of Investigation Derived Waste
- SOP 23: Secchi Disk Depth (Transparency) Measurement
- SOP 24: Eckman Dredge

3.0 FIELD TASK STATUS

This section summarizes the field investigation tasks to support the data needs of the CERCLA and WRDA programs. It also presents a summary of non-direct field measurements associated with the data collection needs.

3.1. FIELD INVESTIGATION TASKS COMPLETED

Several field investigation tasks have been completed to date. These tasks have provided vital information for the planning of future tasks and in updating the CSM. These tasks include:

- Bathymetric Survey – The bathymetric survey was conducted for the project in 2004 by the USACE. This survey covered much of the 17-mile stretch of the river, extending to RM 15.8. The results of this survey have been combined with historical bathymetric survey results to update the CSM.
- Geophysical Surveys – Geophysical surveys, including side scan sonar (SSS), sub-bottom profiling, and a magnetometer survey, were conducted in 2005 to support characterization of the nature of the river bottom sediment type, selection of coring locations, and the function and structure of potential restoration sites. A complete description of the field activities associated with these surveys is presented in Section 4.3 of FSP Volume 3 (Malcolm Pirnie, Inc., 2005b).
- Geotechnical Sediment Coring – Geotechnical sediment coring was conducted in 2005 to obtain confirmatory "ground truth" samples to calibrate and verify the SSS and sub-bottom profiling geophysical surveys. A complete description of the field activities associated with these surveys is presented in Section 4.3 of FSP Volume 3 (Malcolm Pirnie, Inc., 2005b).
- Sediment Transport Studies – Sediment erosion measurements were conducted in May 2005 using two devices: 1) Gust Microcosm to understand erosion at the surface and at very low shear stresses and 2) Sedflume to understand erosion at depth and at greater shear stresses. Gust Microcosm is used to measure surface sediment erosion since it can resolve fine differences in shear stress which Sedflume cannot. Sedflume is used to measure erosion with depth, since it can simulate the higher shear stresses that might be encountered during flood conditions. Gust Microcosm was conducted at 6 sites while the Sedflume was performed at 15 locations. In addition, about 8 surface sediment samples [0 to 0.2 inches (0 to 0.5 cm)] were collected during the collection of the sediment cores for the erosion field experiments, for Be-7 and Th-

234 analysis. These radionuclides are tracers of the short term particle dynamics in the river. Details of the sediment erosion experiments, sediment coring for the analysis of short-lived radionuclides, including the data needs, and the rationale for selecting the site locations, are presented in the Hydrodynamic and Sediment Transport Sampling Plan for 2004-2005 and Site Selection Rationale Memorandum in Attachment 2 of this document.

3.1.1. Field Investigation Tasks Planned for 2005

The field tasks planned for 2005 include:

- High Resolution Sediment Coring;
- Low Resolution Sediment Coring – Initial Program;
- Tidal Water Column Monitoring – Initial Sampling;

These tasks are described in the Sections 4 "High Resolution Sediment Coring", 5 "Low Resolution Sediment Coring", and 6 "Tidal Water Column Sampling" of this document.

3.1.2. Future Investigation Planned for 2006

The field tasks planned for 2006 include:

- Low Resolution Sediment Coring – Continued Program;
- Porewater and Groundwater Sampling;
- Mudflat Sediment Sampling;
- Long-term Tidal Water Column Monitoring;
- Tributary and Head of Tide Water Column Monitoring.

The details of the field activities associated with these tasks will be presented as insertions to future versions of the FSP. Placeholder sections are part of this document to indicate where these programs will be described in the future.

3.2. NON-DIRECT MEASUREMENTS

There are several non-direct measurements that will be used during the investigation. These non-direct measurements, which include: historical data for various media, atmospheric deposition measurements, hydrodynamic studies, and fresh water inflows, are discussed below.

3.2.1. Historical Data

Previously, electronic historical data were obtained from various sources and were uploaded to the PREmis database. Historical data and information on the Passaic River are also available on the public website http://www.ourPassaic.org. A summary of the types of data available, the quality of the data, the results of preliminary evaluation, and the use of the data in developing the initial CSM is described in the Work Plan (Malcolm Pirnie, Inc. 2005c).

3.2.2. Atmospheric Deposition

Atmospheric deposition is the contribution of atmospheric pollutants or chemical constituents to land or water ecosystems. It consists of wet deposition via rain and snow, dry deposition of fine and coarse particles and gaseous air-water exchange. Atmospheric deposition loadings will be calculated based on data provided by the New Jersey Atmospheric Deposition Network (NJADN). The NJADN data were collected by researchers from Rutgers and Princeton Universities, with support from the Hudson River Foundation, New Jersey Sea Grant, and NJDEP. Up to four (4) NJADN stations were identified for application to model input:

- Liberty State Park – Applied to Harbor (*i.e.*, Hudson River below Haverstraw Bay, Upper Bay, Newark Bay, Arthur Kill and Kill van Kull, East River, Harlem River, Jamaica Bay);
- Sandy Hook – Applied to open water areas (*i.e.*, Lower Bay and New York Bight, Raritan Bay, Long Island Sound);
- New Brunswick – Applied to urban tributary areas (*i.e.*, Hackensack, Passaic, and Raritan Rivers);

- Chester – Applied to northern less urbanized areas (*i.e.*, Hudson River above Haverstraw Bay).

Some or all of these stations may be used to develop deposition over the open water areas. Atmospheric deposition loadings to the model used for the Study Area will use the available NJADN data for the following chemicals: total polychlorinated biphenyls (PCBs), PCB homologues, dioxin/furan congeners, polycyclic aromatic hydrocarbons (PAHs), pesticides, and metals including mercury. Representative chemicals from these chemical classes will be chosen for inclusion in the model based on physicochemical properties, modeling efficiencies and the decision needs of the Study.

Currently, historical deposition fluxes for PCB homologues, gases, particles, and precipitation at each of the four stations are available from NJADN and may be applied directly to the model. For mercury and cadmium, historical gas, particle, and precipitation flux data are available from NJADN on a harbor-wide basis and these will be applied to the entire model domain. For dioxin/furan congeners, NJADN did not calculate fluxes, but provided historical gas and particle concentration measurements for the Liberty State Park, Sandy Hook, and New Brunswick stations. NJADN protocols will be used to develop the concentration measurements into fluxes. The New Brunswick data will be applied to both urban and northern, less urbanized tributary areas since Chester data are not available for dioxin/furan congeners.

Details of the framework for deposition calculation are described by researchers associated with the NJADN (Totten *et al.*, 2004, Gioia *et al.*, 2005; Gigliotti *et al.*, 2005). In particular, the calculation of the dry deposition flux depends on assumed values of the particle deposition velocity, and a value of 0.5 cm^{-1} is used by NJADN (metric units used for precision). Typical values reported for dry deposition velocities range from 0.2 to 0.9 cm^{-1}, resulting in uncertainties of over 100% in the estimated dry deposition flux (Gigliotti *et al.*, 2005). It is anticipated that the dry deposition flux of chemicals of potential concern (COPCs) and chemicals of potential ecological concern (COPECs) is important to the overall mass balance, and such uncertainties in dry deposition will be evaluated through a sensitivity analysis.

3.2.3. Water Inflows

The U.S. Geological Survey (USGS) maintains long term data of hydrologic discharges in the Passaic River at Little Falls and three tributaries: the Saddle River at Lodi, the Third River at Passaic, and the Second River in Belleville. Time series data of water inflow from these stations will be used to specify the discharge at boundary conditions. Because the upstream boundary of the study area is at the Dundee Dam, the data from Little Falls will be used to determine a relationship between river discharge at Little Falls and discharge data that will be collected at Dundee Dam during the monitoring program. This relationship will allow for the reconstruction of historical discharges at Dundee Dam..

3.2.4. Hydrodynamic Measurements

Rutgers University, USGS, and Malcolm Pirnie are currently conducting a hydrodynamic study of the Lower Passaic River, with Rutgers and USGS focusing on the lower six miles to aid in the implementation of a pilot dredging study and Malcolm Pirnie focusing on the upper 11 miles to collect data to evaluate remedial options in the entire 17-mile stretch. During these studies, hydrodynamic parameters, including temperature, current, salinity, and depth, are monitored at fixed moored stations and during shipboard surveys under various river discharge and precipitation conditions. These measurements of the physical variables of interest within the modeling domain will be used in calibrating and validating the hydrodynamic model. More information on this effort is provided in the Hydrodynamic and Sediment Transport Sampling Plan (Attachment 2 to FSP Volume 1).

3.2.5. Vertical Mixing/Bioturbation

Vertical mixing of the sediments can be achieved by tidal flows, storms, wave action, boat traffic, scouring by ice or debris, dredging, and other physical processes, as well as by biological processes (bioturbation). The effects of physical processes cannot often be easily discerned from those due to biota. However, the net effect of the various processes is essentially the same – to mix the uppermost layers of the sediment.

Within stable sediment deposits, the most important natural process that brings contaminants to the sediment surface is bioturbation. In general, bioturbation is the active mixing of sediments by aquatic organisms. Bioturbation occurs in the uppermost layers of sediment in which the animals reside, with the most intensive activity in surficial sediments (generally on the order of centimeters), and a decrease in activity with increasing depth (Clarke, *et al.*, 2001). In addition, the depth of mixing is also greater for marine/estuarine environments compared to freshwater environments. The extent and magnitude of the alteration caused by bioturbation depends on site location, sediment type, and the types of organisms and contaminants present.

The effects of vertical mixing can include:

- Alteration of sedimentary structures, thereby affecting analysis of the depositional history of sediments.
- Alteration of chemical forms of contaminants.
- Bioaccumulation in the tissues of benthic organisms resulting from exposure to deeper, more contaminated sediment.
- Transport of contaminants from the sediment to interstitial/pore water or the water column.
- A decrease in cohesion and bulk density due to burrowing (Boudreau, 1998).
- An increase or decrease in the ability of the sediment bed to resist erosion.
- Binding sediment particles and increased cohesion, due to secretions associated with tube building activities.

Because the effects of bioturbation are site-specific and can exhibit substantial spatial and seasonal variation, site-specific data will be required to scale the depths of the mixing zones in the freshwater, transitional, and brackish sections of the Passaic River. The scale of mixing and the sediment properties of surficial Passaic River sediments will be determined through the following:

- Measurements of short-lived (Be-7 and Th-234) radioisotopes in the top segments of sediment cores (including high resolution, and low resolution cores).
- High resolution X-radiograph and/or bulk density profiling of sediment cores (low resolution cores and mudflat cores).
- Sediment Profile Imagery (SPI) using a camera inserted into the sediments to photograph cross-section of sediment and biotic activity. The SPI will be used in conjunction with sediment cores collected during geophysical surveys to evaluate benthic populations residing in the Lower Passaic River. This device provides a snapshot of organisms residing in the shallow sediments, thus aiding in delineating the biologically active zone (BAZ) and identifying benthos present. Procedures for conducting SPI can be found in FSP Volume 3 (Malcolm Pirnie, Inc., 2005b).
- Oxidation-Reduction profile measurements to provide in-situ determination of reducing-oxidizing discontinuity, during high resolution, low resolution and mudflat sediment coring.

4.0 HIGH RESOLUTION SEDIMENT CORING

4.1. DATA NEEDS AND OBJECTIVES FOR THE HIGH RESOLUTION CORING PROGRAM

The objective of the High Resolution Coring Program is to investigate the depositional chronology and associated contaminant distribution in the Study Area. The data from these cores will assist in the development of the CSM by describing the nature and extent of current and historical inputs of contaminants. The High Resolution Coring Program supports the following data needs and satisfies the DQO questions 7, 8, 9, and 11 found in the QAPP (Malcolm Pirnie, 2005a):

- Determine the nature and extent of contamination by analyzing sediment samples for PAHs, PCB, polychlorinated dibenzodioxins/furans (PCDD/F), pesticides, and metals (refer to DQO tasks 7A and 8A).
- Estimate current inventory for each contaminant, including an estimate of total mass of contamination in the Study Area (refer to DQO tasks 7A and 9D).
- Determine the geochronology of contaminants, evaluate depositional rates and types of depositional environments, and identify major hydrologic/depositional events that can be discerned in the sediment core (refer to DQO tasks 7D and 8F).
- Estimate how external and internal sources have varied over time and evaluate diagnostic fingerprints of source(s) over time (refer to DQO task 11A).
- Evaluate extent of diagenesis and mixing/ bioturbation that will affect the availability and transport of contaminant inventory over time (refer to DQO task 7D).

4.2. HIGH RESOLUTION CORING SCOPE AND METHOD

4.2.1. Scope of High Resolution Coring Program

To satisfy these data needs, the scope of the field coring program is to collect high resolution cores that penetrate to a depth that corresponds to sediments deposited at the turn of the twentieth century (approximately 1900). Note that a subset of these cores will only extend to the 1950s. The program will include 15 coring locations plus 5 or more alternative locations. Alternative cores will be collected if coring locations are rejected in the field. Coring locations may be rejected based on material type, sediment layer thickness, or other field conditions. As discussed in Section 4.2.3, 13 target areas have been identified using the below described process. The 15 cores locations and 5 alternative coring locations will be collected from these 13 target areas.

It is anticipated that from the total 20 coring locations, at most 8 high resolution cores will be fully analyzed for contaminants. (Refer below to Section 4.2.4 "Sample Handling and Analysis of High Resolution Cores" for information on selecting cores for analyses.) However, during the sampling program implementation, some decision points may require collecting additional high resolution cores beyond the 5 alternative coring locations so that 8 complete cores may be produced. These decision points are presented graphically on Figure 4-1, which provides a decision strategy for the High Resolution Coring Program, including:

- Do the recovered cores meet percent recovery and sample quality goals (*e.g.*, a minimal number and size of voids[1])? If the quality or recovery of the core is inadequate, or if the core is not intact, then the core will be rejected and additional cores are required.
- Do the results of the radionuclide dating of the core segments meet data quality goals and will they withstand a rigorous geochemical evaluation without indication of inconsistencies? If the radionuclide data suggest inconsistencies or discontinuities in the core, then the core will be rejected and additional cores are required.

The 15 coring locations will be distributed throughout the Lower Passaic River and above the Dundee Dam. Cores collected within the Lower Passaic River will gather sediment data specific to the Brackish River Section (RM 0 to RM 6), Transitional River Section (RM 6-12), and Freshwater River Section (RM 12 to Dundee Dam). Cores situated upriver of the Dundee Dam will define the contaminant load at the upper boundary of the Study Area. Refer to the CSM [Attachment A of the Work Plan (Malcolm Pirnie, Inc., 2005c)] for a further description of these river sections. Table 4-1 provides detail regarding the distribution of the 15 coring locations among these river sections; as noted above, cores from 8 of the 15 locations will be analyzed for chemical contaminants. (Refer to Section 4.2.2 below "Selection Process of Coring Locations" for rationale on selecting specific sites for coring.)

[1]: SOP 11 attached describes the percent recovery and voids sizes acceptable for cores. For high resolution cores 85% recovery with no voids is the criteria as judged in the field by the processing staff.

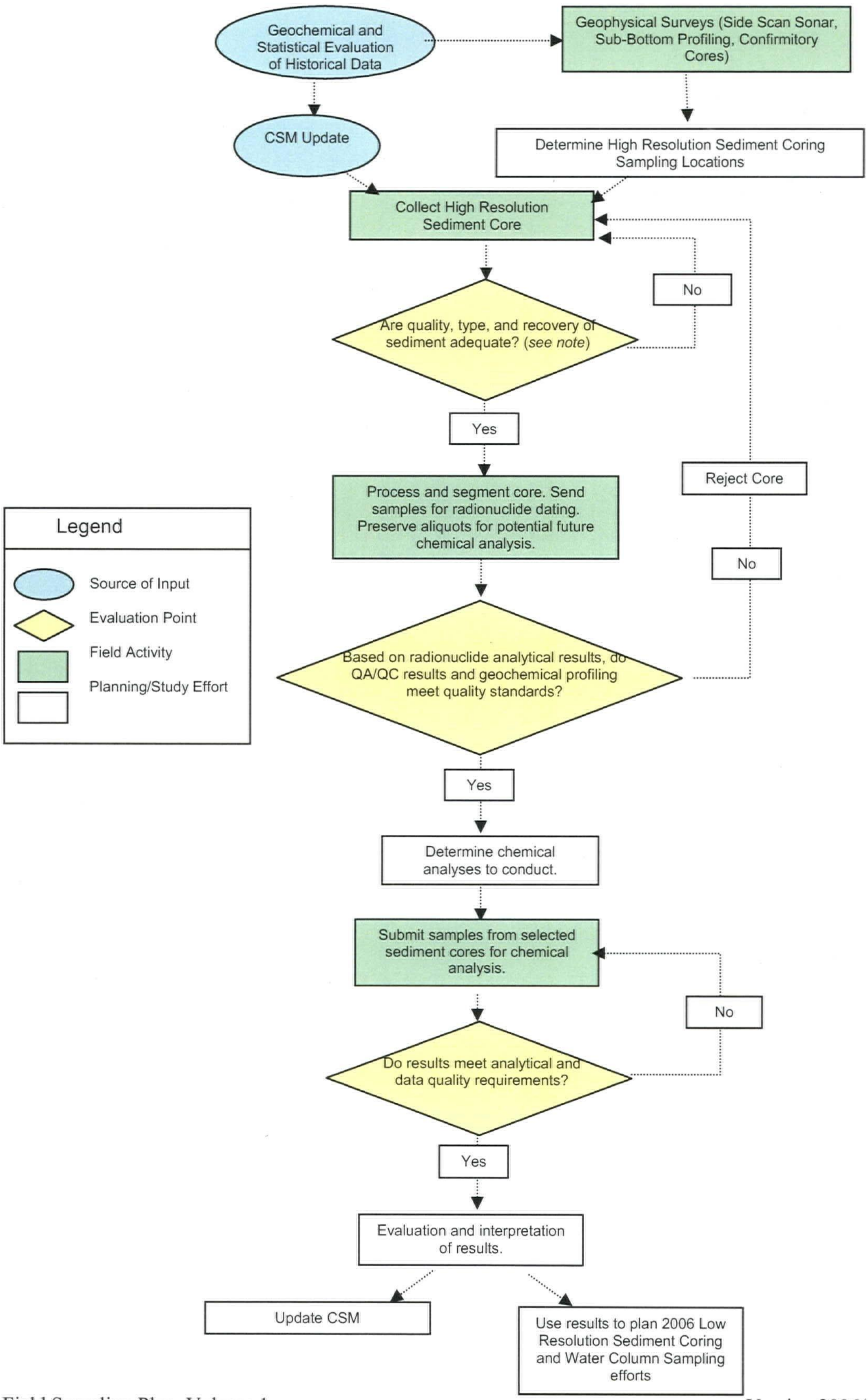
Table 4-1: High Resolution Target-Coring Locations

River Section	*Number of Locations*	*Target Core Length (feet)* [1]
Brackish Section (RM 0 to RM 6)	5	20
Transitional Section (RM 6 to RM 12)	4	15
Freshwater Section (RM 12 to RM 17.4)	3	10
Upriver of Dundee Dam	3	10
TOTAL	*15*	*NA* [2]

(1) The actual core length may be less than the proposed length if the core encounters refusal at a shallower depth. Based on the depth of penetration from the geotechnical borings, the anticipated core lengths reported in this table are likely greater than will be achieved in the field.
(2) NA = Not Applicable.

At each of the 15 coring location, a minimum of 2 cores will be collected with a possible third core (total of up to 45 cores for the program), including a sample core, an archival core, and a potential duplicate sample core (SOP 9 Vibracoring – Collecting High and Low Resolution Cores in Attachment 1). This potential duplicate core will be collected in target areas where sediment is less than 12 feet thick. Both cores will be analyzed for radiological dating and the other geochemical analyses will be distributed between the two cores (*e.g.*, the sediment for metals analyses come from one core while sediment for PCB analyses may come from the other) to assure that there is sufficient sample for all planned analyses (SOP 11 Core Processing – High Resolution in Attachment 1). The decision process for the high resolution core strategy is presented in Figure 4-1.

Figure 4-1: Decision Strategy for High Resolution Sediment Coring Efforts



4.2.2. Selection Process of Coring Locations

The coring sites must be located in depositional environments containing fine-grained sediments to assure successful collection of high resolution cores, containing complete radiological datasets and extending to the appropriate time horizon. To locate suitable depositional environments for coring, several sets of existing data will be considered in the site selection process. The best candidate coring locations can be chosen by combining or overlaying information on river sediment conditions, including data on sedimentation rates, historical depth of contamination, geotechnical borings, sediment texture, surficial grain size, historical radiological data, and Sedflume[2] results. Table 4-2 provides an overview of the available information, which will be used as data layers in a Geographic Information System (GIS) framework.

Table 4-2: Geographical Information Layers Used in Site Selection

Geographic Information Layer	*Contribution to Site Selection Process*	*Extent of Data Set*	*Data Source*
Sedimentation Rate	Identify areas of deposition and non-deposition	RM 0 to RM 15	1989 and 2004 bathymetric surveys
		RM 0 to RM 7	1995 and 2001 bathymetric surveys
Depth of Contamination	Estimate sediment depth where concentration of total DDT goes to zero (~1925)	RM 0 to RM 7	Passaic 1995 RI Sampling by Terra Solutions, Inc.
Geotechnical Borings	Provide profiles of sediment type for cores penetrating to refusal	RM 0 to RM 16	2005 MPI/Aqua Survey Geophysical Survey
Sediment Texture	Identify distribution of sediment texture based on SSS survey	RM 0 to RM 16	2005 MPI/Aqua Survey Geophysical Survey
Surficial Grain Size	Identify grain size distribution in sediment (0 to 6 inch)	RM 0 to RM 16.5	2005 MPI/Aqua Survey Geophysical Survey
Historical Radiological Data	Identify areas impacted by a major hydrological or depositional event	RM 0 to RM 7	Passaic 1995 RI Sampling by Terra Solutions, Inc.
Sedflume Results	Provide sediment characteristics at Sedflume locations	RM 0 to RM 14.5	2005 USACE-ERDC

[2]: Sedflume is a technique for measuring location specific erodibility of sediments within the Study Area.

The following discussion describes the application of each of these data sources to the process of coring site selection.

Sedimentation Rates

Maps of local sedimentation rates can be used to focus high resolution core site selection in areas of high sediment accumulation rates. Similarly, it can be used to eliminate areas where deposition is low or lacking since these areas are unlikely to have ideal depositional environments.

The "sedimentation rate" is derived from a comparison of two bathymetric surveys conducted at two points in time. The sedimentation rate at each river location is determined by calculating the change in bathymetry from 1989 to 2004 divided by the 15-year period between the two surveys to create a map of sediment deposition in inches per year. The 1989 bathymetric survey was conducted by Tallamy, Van Kuren, Gertis and Associates, and the 2004 bathymetric survey was conducted by Rogers Surveying, Incorporated. [Refer to *Technical Memorandum: Preliminary Geochemical Evaluation* found in Attachment B of the Work Plan (Malcolm Pirnie, Inc., 2005c).] This informational layer is presented in a series of three maps in Attachment 3 where sedimentation rates are differentiated through a series of colors. Gray on the maps represents areas of non-deposition or scouring. Areas of deposition are colored with the lowest sedimentation rate represented by blue grading through yellow to red, which represents areas where sedimentation rates exceed 5 inches per year. Note these sedimentation rates represent the average annual deposition from 1989 to 2004; however, short term sedimentation rates are likely to have varied substantively over this period.

The sedimentation rates vary throughout the Lower Passaic River. The Brackish River Section is characterized by extensive deposition at the river mouth, from RM 0 to RM 1.5, with sedimentation rates exceeding 5 inches/year. Other depositional areas occur near RM 2 and RM 4, with sedimentation rates greater than 3 inches/year. In general, non-depositional zones tend to be located on the banks and depositional zones tend to be located in the channel. While sedimentation rates remain heterogeneous in the Transitional and Freshwater River Sections, large areas in these river sections are non-depositional with a few sporadic high depositional areas. For example, in the Transitional Section, areas near RM 6.5 and RM 10 have sedimentation rates greater than

2 inches/year. In the Freshwater Section, small areas near RM 12.5 and RM 14 are depositional with sedimentation rates greater than 5 inches per year.

Depth of Contamination

The local depth of contamination, as established by historical core collection, can be used to identify those locations where a thick sequence of contaminated sediments exists. At some of these locations, it should be possible to obtain a relatively long high resolution sediment core, thereby providing ample sample volume for each core segment.

Bopp *et al.* (1991) established that 4-4'-Dichlorodiphenyltrichloroethane (DDT) contamination extends fairly deep within the sediments, first appearing in the sediments prior to 1945. As such, the depth of DDT appearance in the sediments can be used as a marker to identify locations with high deposition rates, or thick sediment beds. Combining the observations of Bopp *et al.* with the coring results obtained by Tierra Solutions, Inc. (low-resolution sediment cores were collected in 1995 from RM 1-7 and analyzed for total DDT), a map of the depth of sediment contamination was constructed to identify the potential depth of total DDT contamination. This information layer was then overlaid on the sedimentation map in Attachment 3; symbols (circles, triangles, and squares) classify the type of core collected and call-out boxes mark the depth of contamination in feet. (Note that total DDT is defined as the sum of 4,4-DDT, 4,4-DDD, and 4,4-DDE; where laboratory results flagged with a not detected [U] denotation were set equal to zero.)

- Complete Core (circle): the concentration of total DDT at the bottom of the core equals a non-detectable value (treated as zero). The "depth of contamination" is defined as the depth of the core-segment top where total DDT=0.
- Incomplete Rising Core (triangle): the concentration of total DDT at the bottom of the core is increasing or "rising." The "depth of contamination" is defined as deeper than the depth of the sediment core.
- Incomplete Declining Core (square): the concentration of total DDT at the bottom of the core is declining, but does nor equal zero. Note that to avoid laboratory and sampling error, "declining" is defined as a decrease in concentration by a factor of 3. The "depth of contamination" is defined as deeper than the depth of the sediment core.

Geotechnical Borings

As part of the June 2005 geophysical survey (Aqua Surveys, Inc., 2005), "ground truthing" effort, geotechnical borings were collected in the Lower Passaic River. The borings were organized along transects, one boring drilled adjacent to both bank and one boring drilled on the river centerline. Transects were positioned at each river mile from RM 0 to RM 16, totaling 17 transects. Borings were advanced until refusal, or 30 feet (whichever was first encountered), and sediments were visually classified by a geologist following the unified soil classification system (USCS). Fence diagrams of the borings in each transect are included in Attachment 3. One sample from a distinct stratigraphic zone collected from each boring was submitted for geotechnical analyses to confirm the field notes and USCS classification. The results from these cores provide information on the physical nature of sediments in the Passaic River. In particular, the cores document the thickness of silt and sand layers as well as a color transition from overlying black, possibly organic rich sediments to red brown sediments, which may be indicative of pre- and post-industrial development conditions. These results provide information on both the depth of sediment that may be cored in an area as well as the nature of sediment to be obtained.

Boring logs were converted into cross-sectional profile (Fence Diagrams) to identify the different geological strata in the sediment beds. In these profiles, the boring logs are oriented on the same depth and geographic coordinate system, and similar sediment types are connected into strata based on the USCS classification to create transect cross-section. The cross-sections were used to identify sub-surface sediment types, transitional zones between different sediment types, and depositional environments. This information, in conjunction with the Sediment Texture informational layer, will aid in choosing core locations where fine-grained sediments are expected at depth.

A review of the boring logs shows distinct differences among the sediments of the Lower Passaic River. For example, borings drilled in the Freshwater River Section (RM 12 to RM 17.4) generally encountered refusal before penetrating 4 feet. Sediments at RM 16 were characterized by poorly sorted gravel, which slowly transitioned to silty sand with gravel in RM 12. Note that sediments adjacent to the shoreline tend to contain more silts than the sediments at the centerline. In the Transitional River Section (RM 6 to RM 12), borings could be advanced to approximately 7 feet with sediments continuing to become finer down-estuary with beds dominated by silt, fine sand, and organic matter. Following this trend of sediment thickening and fining down-estuary, borings drilled in the Brackish River Section (RM 0 to RM 6) advanced more than 10 feet with the deepest boring advanced to 33 feet below the sediment/water interface. Sediments from the Brackish Section were dominated by silt and clay of varying plasticity.

Sediment Texture

High resolution cores are typically most "successful" when obtained from areas of fine-grained sediments; hence, a map identifying areas of fine-grained surficial sediments (identified through the SSS survey) will serve to focus the core collection efforts.

As part of the June 2005 geophysical survey, Aqua Surveys Inc. conducted SSS and sub-bottom profiling of the Lower Passaic River Study Area. The survey provides surficial sediment texture mapping, which was compared to the geotechnical boring survey to aid in determining surface and near-surface sediment types. A sub-bottom profiling survey was also conducted and is expected to provide information on sediment stratigraphy.

SSS mosaics were combined with the results of the shallow (0 to 6 inch) confirmation cores (refer to "Surficial Grain Size Distribution" below) to generate a simplified-surficial sediment texture map (Attachment 3). This map also contains contour lines relative the vertical datum NGVD29. Note that the sediment texture map only displays surficial sediment texture and does not identify sub-bottom sediment texture. In general, the Brackish River Section is dominated by silts, which mainly occur in the channel. Larger grain sizes are become more predominant on the shoreline. The Transitional River Section is characterized by a transition of sediment texture from mainly silts in RM 7 to coarse-grain sediments at RM 12. This coarse-grained sediment texture persists in the Freshwater River Section with granular material dominating RM 16. The data in this geographical information layer is consistent with the data obtained with the geotechnical borings.

Surficial Grain Size Distribution

As part of the June 2005 geophysical survey, shallow confirmatory cores were collected to support the interpretation of the SSS imagery. Five shallow cores (advanced up to 1 foot) were collected along each transect. Transects were positioned approximately every ½ mile from RM 0 to RM 16.5. Additional cores were placed in areas selected by the field geophysicist as areas of interest, yielding 275 shallow cores.

Of these cores, 100 cores were selected for geotechnical analyses including grain size, hydrometer of silt and clay, and total organic carbon. (Note that geotechnical analyses were conducted on a composite sample from the top 0.5-foot interval of the shallow confirmation core.) Criteria for selecting the 100 cores for geotechnical analyses included at least one sample per transect and selecting samples of unique sediment types to confirm the SSS results.

A map showing the locations of the shallow confirmatory cores is presented in Attachment 3 along with histograms of the grain size results. These histograms confirm the geotechnical borings findings, with coarse-grained surficial sediment typically located upriver of RM 6 while fine-grained silt and clay are located between RM 0 and RM 6. This attribute is displayed by plotting the 50% percentile grain size against river mile (Attachment 3). The Brackish River Section tends to have surficial sediment with median grain sizes ranging from 0.01 mm to 0.1 mm whereas the Transitional and Freshwater River Sections tend to have surficial sediments with grain sizes that are larger than 0.1 mm.

It is anticipated that fine-grained surficial sediments correlate with depositional areas and coarse-grained surficial sediment correlate with non-depositional areas. To examine this correlation, the grain size sampling locations were projected onto the sedimentation map, which is shown in Attachment 3, to connect grain size to a point-specific, sedimentation rate. [Note that only 71 of the 103 grain size samples overlapped with the sedimentation map (*i.e.*, samples located in RM 0 to RM 15).] The average sedimentation rate for the various grain sizes were computed and presented in tabular form in Attachment 3. As expected, the grain size decreases as the average sedimentation rate increases. However, this correlation does not hold true for sediments containing coarse-grained sediments and gravel. A geographic informational layer of 50 percentile grain size will be considered when selecting core locations.

Historical Radiological Data

Existing data on sediment radionuclide profiles can be used in a manner similar to that of the depth of DDT contamination described previously, that is, to identify areas of thick sediment deposits, potentially with steady rates of deposition. Locations with ideal radionuclide profiles will be identified as possible coring sites. Down-core profiles of radiological data (cesium-137 and lead-210) were constructed as part of the *Technical*

Memorandum: Preliminary Geochemical Evaluation [found in Attachment B of the Work Plan (Malcolm Pirnie, Inc., 2005c)]. These profiles will be referenced to identify possible coring sites based on good profiles as well as to identify areas where depositional discontinuities may already exist within the sediment beds. The radionuclide data are limited to the lower 7 miles of the Passaic River.

<u>Sedflume Results Data</u>

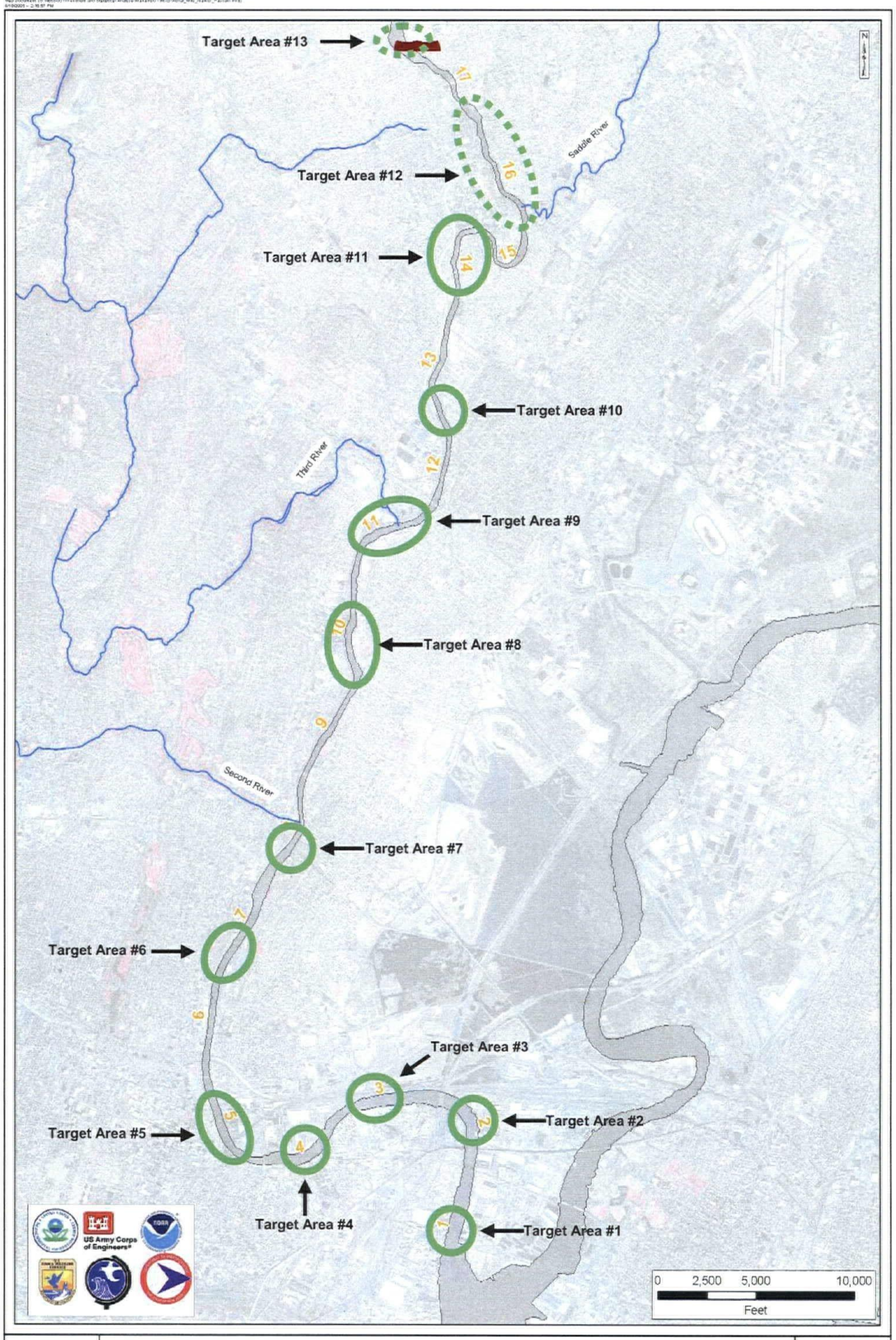
As part of the Sedflume experiments, sediments (approximately 0 to 1.3 feet) were characterized for bulk density, total organic carbon, and grain size. This information provides a general characterization of Passaic River sediments that will be considered in the design of the coring program.

4.2.3. Proposed Sites for High Resolution Coring

Using the information discussed above, 13 target coring areas were chosen. Within these 13 areas, 15 coring locations and 5 alternative coring locations will be identified in the field. Figure 4-2 shows the areas where high resolution core locations will be chosen in the field. Table 4-3 provides more information on each target area.

Table 4-3: Preliminary High Resolution Target Coring Locations

Target Area	Approximate River Mile	Description	Qualifier
1	1.0	Thick sediment beds of silt, black/brown color transition, and high sedimentation rates.	Good Location
2	2.0	Thick sediment beds of silt, black/brown color transition, and medium sedimentation rates.	Good Location
3	3.0	Thick sediment beds of silt, black/brown color transition, and medium sedimentation rates.	Good Location
4	4.0	Thin sediment beds of silt, black/brown color transition, and medium sedimentation rates.	Good Location
5	4.5 to 5.0	Potential depositional environment; location dependent on field investigation.	Anticipate Good Location
6	6.5 to 7.0	Potential depositional environment; location dependent on field investigation.	Anticipate Good Location
7	8.0	Potential depositional environment, thin sediment beds of silt, and black/brown color transition; location dependent on field investigation.	Anticipate Good Location
8	10.0	Potential depositional environment, thin sediment beds of sandy-silt, and bluish-gray/brown color transition; location dependent on field investigation.	Fair Location
9	11.0 to 11.5	Potential depositional environment, thin sediment beds of sandy-silt, and bluish-gray/brown color transition; location dependent on field investigation.	Fair Location
10	12.5	Potential depositional environment, thin sediment beds of silt, and grayish-olive/brown color transition; location dependent on field investigation.	Fair Location
11	14.0 to 14.5	Potential depositional environment, thin sediment beds of silt, and grayish-olive/brown color transition; location dependent on field investigation.	Fair Location
12	15.5 to 16.5	Location dependent on field investigation.	Unknown
13	Above Dam	Anticipate thick sediment beds of silt and high sedimentation rates.	Good Location



Preliminary High Resolution Coring Target Areas

Lower Passaic River Restoration Study

Figure 4-2

August 2005

The choice of core locations within target areas will be based on field reconnaissance and sediment screening. This field reconnaissance will inspect small scale feature within the target areas, such as former bridge abutments, historic docks and piers or small tributary confluences, where long-term sediment deposition is expected to occur. Hand core samples will be collected at promising core location and sediment thickness will be probed (see SOP 8 Sediment Probing and SOP 13 Sediment Collection Using Hand Coring Devices in Attachment 1). The sediment thickness will be assessed in the field to determine if sufficient sample is available at the core location for the planned high resolution analyses (greater than 12 feet of black or blue-gray sediment) and the core top (0 to 0.5 inches) will be collected and sent to the laboratory for Be-7 analysis. It is anticipated that up to 30 locations will be screened following this process. The information gathered from the core observation and from the Be-7 analyses will be used to determine the 15 most promising and 5 alternative target coring locations (discussion of the Be-7 study conducted to locate promising high resolution core sites is presented in Attachment 3).

The goal of selecting 15 coring locations is to yield 12 to 15 cores that will be further screened by radionuclide analysis to produce 8 complete cores that are suitable for chemical contaminants analyses. These cores will be distributed throughout the river and above the Dundee Dam. Note that it may require more than 15 locations to yield 8 complete cores; therefore, up to five alternative locations may be needed. Table 4-4 shows the number of complete cores that will be retrieved per river section relative to the number of target coring locations. The expected number of complete cores (shown in Table 4-4) will not increase and may, in fact, decrease if the situation arises that all the cores collected from a given river section are deemed unsuitable for subsequent chemical analysis.

Table 4-4: Complete High Resolution Cores

River Section	Number of Locations	Expected Number of Complete Cores
Brackish Section (RM 0 to RM 6)	5	3-4
Transitional Section (RM 6 to RM 12)	4	2-4
Freshwater Section (RM 12 to RM 17.4)	3	1-2
Upriver of Dundee Dam	3	1
TOTAL	**15**	**8**

Above the Dundee Dam, one complete high resolution core is expected from the 3 coring locations selected. This core is intended to capture sediment geochronology and geochemistry at the upper boundary of the Study Area. Likewise, of the 3 target coring locations in the Freshwater River Section, one (possibly two) complete core is expected to characterize the Freshwater River Section; to evaluate differences and similarities between the Freshwater River Section and above Dundee Dam; and to assess the contributions from Saddle River. Three complete cores (possibly four) are expected in the Transitional River Section from the 4 target coring locations to characterize this river section. These cores will be distributed upriver and downriver of the confluences with Second River and Third River to assess the contributions from these tributaries. Finally, 3 (possibly 4) complete cores are expected in the Brackish River Section from the 5 target coring locations. One core will be positioned at the mouth of the Passaic River while the other two cores will be situated to: confirm historical coring data; estimate current potential sources; and characterize the Brackish River Section. Note that 5 target coring locations are proposed for the Brackish River Section since this area is prone to disturbances (*e.g.*, historical dredging and boat traffic) that may affect the geochronology of a sediment core. One additional core may be added to the total for any one river section in the event that the other river sections do not yield their expected number of cores. Nonetheless, the overall number of cores to be chemically analyzed will not exceed 8. Depending on the success of the core site selection, radionuclide analysis will be done on as many as 15 cores.

4.2.4. Sample Handling and Analysis of High Resolution Cores

In general, cores will be advanced using a vibracoring method that contains a Lexan or polycarbonate core tube with a 3.75-inch to 4.0-inch diameter (refer to SOP 9 Vibracoring – Collecting High and Low Resolution Cores in Attachment 1). Alternate methods (SOP 10 Split Spoon Sample Collection; and SOP 13 Sediment Collection Using Hand Coring Devices in Attachment 1) may be employed by the selected contractor if it can be demonstrated that an "undisturbed" core can been collected and that the core sample can be processed into representative "undisturbed" segments. Once collected, cores will remain in a vertical orientation and will be transported to the field office for processing (refer to SOP 11 Core Processing – High Resolution in Attachment 1). The archival core will be frozen for future analyses, as appropriate, without further processing.

Sample cores and any duplicate sample cores will be segmented into approximately 40 to 44 samples. An aliquot from each of the 40-44 samples will then be frozen for future chemical analysis of mercury (other metals), pesticides, PAHs, PCB congeners, and PCDD/F. The frozen aliquots will be analyzed after the radiological data is reviewed [and within the required holding time of frozen aliquots (refer to SOP 11 Core Processing – High Resolution in Attachment 1)].

To process cores and review radiological data efficiently, the following approach will be instituted:

- Analyze every other of approximately the upper 30 segments from each core for cesium-137 (Cs-137) and lead-210 (Pb-210). The Cs-137 analysis will identify two time horizons (1954 and 1963) in the cores, which can then be used to calculate a point-specific sedimentation rate. The Pb-210 analysis will provide a second, point-specific sedimentation rate and will identify any major hydrological/depositional event that may have caused a discontinuity in the geochronology of the sediment core. If necessary conduct Cs-137 and Pb-210 analyses of specific un-analyzed segments to bring higher resolution to the profile.
- The analyses for total organic carbon, bulk density, and grain size must be conducted immediately after the cores are collected to satisfy the holding time requirements for these analytes. Samples will be collected once the cores have been properly segmented.
- Assuming that no discontinuities are present in the Pb-210 geochronology and that the point-specific sedimentation rates calculated for Cs-137 and Pb-210 are consistent, combine the 40-44 frozen aliquots to form 20-22 samples for further chemical analysis or if the profile warrants use the top 20 to 22 aliquots. These 20-22 samples should contain sediments deposited during the different time periods represented by each core. Samples will be analyzed for mercury (other metals), pesticides, PAHs, PCB congeners, and PCDD/F.

With this approach, cores from up to 8 of the original 15 coring locations will be analyzed for geochemical parameters. However, if discontinuities are present in the Pb-210 dataset or other radionuclide disturbances are evident, the remaining cores may need to be analyzed for radionuclides and/or re-evaluated to achieve 8 complete, high resolution core datasets (refer to SOP 11 Core Processing-High Resolution in Attachment 1).

High Resolution Coring sediment sample analytical parameters are listed in the Data Needs/Data Uses Table in Attachment 1 of the QAPP (Malcolm Pirnie, Inc., 2005a).

4.3. HIGH RESOLUTION CORE REPORTING

The deliverable will be a technical memorandum describing the procedures used (along with field notes), description of complicating factors that occurred during the field work, results of the analyses, recommendations on how to update the CSM, and recommendations for future high resolution coring studies.

5.0 LOW RESOLUTION SEDIMENT CORING

5.1. DATA NEEDS AND SAMPLING OBJECTIVES

The objective of the Low Resolution Sediment Coring Program is to generate data on the nature and spatial extent of the contaminated sediments, characterize physical properties of the sediment for remedial alternative evaluations, and support both risk assessment and modeling data needs [refer to DQO Subtopics 7, 8, 11, 15, 20, and 22 found in the QAPP (Malcolm Pirnie, 2005a)].

5.2. LOW RESOLUTION SEDIMENT CORING SCOPE

In the lower 7 miles of the Study Area up to 10 cores will be collected in winter, 2006 to augment and evaluate the 1995 TSI data set. The winter 2006 co-located cores will be positioned to:

- Target locations where analyses of the TSI data suggest that significant concentrations of contaminants exist below the terminal depth of the core (*i.e.*, there is an incomplete sequence of contaminants represented in the TSI core).
- Establish a complete sediment inventory for a broad range of contaminants at the ten locations.
- Investigate the additional sediment accumulation or loss at these sites in the 10 years of erosional and depositional events since the TSI data were collected.

The upper 10 miles of the study area will be investigated with additional low resolution cores during subsequent sampling events. Initially in the upper 10 miles, low resolution cores may be collected on transects, with approximately 3 cores on each transect. The initial transect spacing in the upper 10 miles will provide an initial characterization of this portion of the Study Area, given the reduced amount of historic subsurface sediment data available for this area. Once the initial transects have been completed, additional cores will target specific locations identified from the results. The selection of low resolution coring locations in the upper 10 miles may also be influenced by the evaluation of data from high resolution cores collected in the upper reaches of the study area.

During both the winter 2006 program and subsequent low resolution coring program phases, cores will be advanced until refusal. For planning purposes, cores are estimated to be 20 to 30 feet in length in the lower 7 miles. Low resolution cores in the upper 11 miles are expected to reach refusal at more shallow depths, as encountered during geotechnical coring efforts conducted in early 2005. Sediment Probing (SOP 8 found in Attachment 1) will be used to confirm that the anticipated sediment type at the surface (based on the 2005 side-scan sonar survey) and, if possible, obtain a better estimate of core length at each location before collection is initiated. In some instances the sediment may be too thick to be completely probed by this method.

The 10 low resolution cores planned for winter 2006 will be co-located with TSI 1995 cores in the lower 7 miles of the Study Area based on evaluation of historical data. Cores will be located to confirm the data represented by the historical sampling and to examine the additional impacts of the last 10 years of river activities (*e.g.*, erosional and depositional events). The locations will be relatively evenly distributed across the lower 7 miles and chosen to coincide with historical cores that showed incomplete sequences of dioxin, DDT, and PCBs (*i.e.*, the bottom segments of the historic cores were still contaminated, see Table 5-1). The core locations will also be selected in depositional areas based on historical cores and bathymetric data review, and where silt is the surface material, based on side scan sonar results. Figure 5-1 shows the locations chosen for the winter 2006 low resolution core program.

TSI Core ID	Maximum Concentration of 2,3,7,8-TCDD (ppb)	Bottom Concentration of 2,3,7,8-TCDD (ppb)	Ratio of Bottom Concentration to Max Concentration (2,3,7,8-TCDD (ppb))	Maximum Concentration of DDT* (ppb)	Bottom Concentration of DDT* (ppb)	Ratio of Bottom Concentration to Max Concentration (DDT*) (ppb)	Maximum Concentration of PCBs* (ppb)	Bottom Concentration of PCBs* (ppb)	Ratio of Bottom Concentration to Max Concentration (PCBs*) (ppb)	Sediment Texture	Recommended? Co-located Core Identifier	Depth of Silt (cm)
285	5300	5300	100%	160000	160000	100%	4400	4400	100%	Silt	Y – **LR-9**	480
292	20	20	100%	850	850	100%	34000	34000	100%	Silt	Y – **LR-10**	120
230	15	15	100%	2900	2900	100%	6000	620	10%	Silt	Y – **LR-2**	200
234	29	29	100%	460	280	61%	11000	11000	100%	Silt	Y – **LR-3**	250
227	16	16	100%	3400	870	26%	10000	4500	45%	Silt	Y – **LR-1**	220
243	36	29	81%	1100	590	54%	9200	1000	11%	Silt and Sand	N	
252	24	15	63%	840	840	100%	11000	30	0%	Silt	Y – **LR-6**	230
278	27	12	44%	1800	1800	100%	10000	6000	60%	Silt	Y – **LR-8**	80
260	58	19	33%	930	930	100%	14000	14000	100%	Silt	Y – **LR-7**	100
240	46	13	28%	2500	1500	60%	14000	530	4%	Silt and Sand	N	
245	14	1.9	14%	1400	1400	100%	7200	92	1%	Silt	Y – **LR-5**	500
225	54	1.7	3%	8100	7400	91%	3600	31	1%	Silt	N	
239	23	0.26	1%	1700	1700	100%	1700	32	2%	Silt	Y – **LR-4**	500
244	4.1	0.0057	0%	3400	2.9	0%	1400	29	2%	Silt	N	
241	26	0.033	0%	3000	1300	43%	3300	30	1%	Silt	N	
93A	240	0.3	0%	220000	9900	5%	48000	28	0%	Silt	N	
214	12	0.012	0%	450	450	100%	1100	43	4%	Silt	N	
211	9.8	0.0091	0%	650	13	2%	4600	26	1%	Silt	N	
17A	81	0.051	0%	17000	82	0%	1800	19	1%	Silt	N	
242	34	0.021	0%	2500	1000	40%	3100	31	1%	Silt	N	
228	16	0.0083	0%	2000	450	23%	3900	30	1%	Silt	N	
274	27	0.0069	0%	2400	600	25%	3800	29	1%	Silt	N	
21A	16	0.0024	0%	69	2	3%	1400	20	1%	Silt	N	
248	5.1	0.00061	0%	1900	2.1	0%	7200	21	0%	Silt	N	
231	30	0.0027	0%	3900	200	5%	7400	29	0%	Silt	N	

Table 5-1: Low Resolution Core Location Selection

Legend

Proposed Low Resolution Core

N

2,000 1,000 0 2,000 Feet

MALCOLM PIRNIE	Lower Passaic Restoration Project Proposed Low Resolution Sediment Core Locations	Figure 5-1

Each core segment obtained during the winter 2006 program will be analyzed both using immunoassay screening techniques and standard analytical procedures. The comparison of these analytical methods will be used to determine the utility of such screening methods for subsequent low resolution coring program phases.

During the winter 2006 program, the field investigators will evaluate two main decision points regarding data quality that will be included for each core:

- Do the recovered cores meet percent recovery and quality goals (*e.g.*, a minimal number and size of voids)? A core with less than 75% recovery will be rejected in most instances, subject to the discretion of the field geologist.
- Does the core clearly reach to below the post-industrial revolution sediments?

Additional low resolution cores will be collected, processed and analyzed in Summer-Fall 2006 to complete the evaluation of the spatial extent of sediment contamination. It is possible that 50 to 500 additional low resolution cores may be needed, depending on analyses of the data from the 2005-2006 sediment sampling program. For planning purposes, the high end number is based on coring transects spaced at 300 feet in the upper 10 miles of the Lower Passaic River, with 3 cores on each transect. However, actual selection of core locations will have the objective of reducing the uncertainty in the estimates of the spatial extent of contaminated sediments, and will be made in consultation with the Sampling Work Group.

5.3. LOW RESOLUTION CORE SAMPLE COLLECTION AND PROCESSING

Low resolution core sample collection and processing will be conducted in following SOP 9 Vibracoring Collecting High and Low Resolution Cores and SOP 12 Core Processing – Low Resolution found in Attachment 1. For the winter 2006 program, each of the 10 cores will be sectioned into 6 segments based on the strata found in the cores. The upper portion of each core, expected to represent post-industrial revolution sediments, will be divided into 5 segments and one segment will be collected below these sediments.

Currently it is planned that subsequent phases of the program will also follow this segmentation methodology, except for every third core. In these cases, the top 2 feet or so will be divided into 5 layers to provide the resolution required to define the sediment bed in the sediment transport model and to describe the extent of bioturbation for the risk assessment. Some finer segmentation may be required at depth for radionuclide dating to address geochemical evaluation data needs (according to data gaps identified during evaluation of the high resolution coring data).

For the winter 2006 program, sediment samples will be submitted from each of the 10 low resolution cores for PCB immunoassay and dioxin immunoassay screening analyses immediately after core processing. The winter 2006 cores will also be analyzed continuously to generate vertical contaminant profiles for comparison to the associated historical data for the selected location. All six segments from each of the winter 2006 cores will be sent for analyses. The results of the full analytical and screening techniques will be compared to determine the utility of the screening methods for use in the larger low resolution coring program.

If the screening methods are found to be useful in determining PCB and dioxin concentrations in the sediments, full laboratory analysis in the subsequent program phases may be limited to selected segments, with screening for each collected core and continuous, full laboratory analysis of one representative low resolution cores from each reach. Aliquots of each core segment will be archived in an on-site freezer to allow for further chemical analysis after screening analyses are completed. Following review of the screening sample results, about 10% of the samples that underwent screening will be submitted for the full suite of chemical analyses, by selecting and submitting appropriate archived samples for analyses. Archived samples will be selected to represent a full range of contaminant concentrations, to assess the correlation between screening analyses and more rigorous laboratory analytical results.

Low Resolution Coring sediment sample analytical parameters are listed in the Data Needs/Data Uses Table in Attachment 1 of the QAPP (Malcolm Pirnie, Inc. 2005a).

6.0 TIDAL WATER COLUMN SAMPLING – INITIAL SAMPLING

6.1. DATA NEEDS AND SAMPLING OBJECTIVES

The water column program is needed to support the following data needs and satisfy DQO questions 7, 9, 12, 13 and 18:

1. What are the COPCs and COPECs in the Study Area? (Refer to DQO task 7B.)
2. What are the major sources and processes controlling COPC and COPEC distribution in the Lower Passaic? What is the COPC and COPEC mass balance? (Refer to DQO tasks 9A and 12A.)
3. What is the current and future human health risk associated with exposure to sediment, surface water, and/or consumption of edible portions of fish or selfish? (Refer to DQO task 13A.)
4. What is the current ecological risk associated with exposure to sediment, surface water, porewater, and/or consumption of edible portions of fish or selfish or other edible species? (Refer to DQO task 18A.)

To appropriately address the above questions, field investigations are needed to provide:

- Baseline water column data on COPCs and COPECs for human health and ecological risk assessment.
- Baseline water column data on COPCs and COPECs to understand the fate and transport of dissolved and particle-associated contamination in the Study Area (and to that end, to support the development, calibration, and evaluation of fate and transport models).
- Baseline water quality data to support a remedial investigation designed to determine the nature and extent, and source areas of COPCs and COPECs.

The COPCs and COPECs in the Passaic River system can be categorized into three general groups: (1) hydrophobic organic compounds (HOCs) (*e.g.*, dioxins, PCBs, and PAHs), (2) trace metals and (3) methylmercury. In addition to these COPCs and COPECs, several conventional and hydrodynamic parameters are needed to support fate and transport analysis, eutrophication modeling, and risk assessment. These conventional and hydrodynamic parameters include: Total Suspended Solids (TSS), particulate organic carbon (POC), dissolved organic carbon (DOC), particle size distribution, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total Kjeldahl nitrogen, chlorophyll A, total and orthophosphate, ammonia, secchi disk depth, turbidity, current, temperature, water depth, and conductivity/salinity.

The behavior of COPCs and COPECs in the Passaic River system is influenced by many environmental variables including, but not limited to: pH, temperature, reduction-oxidation conditions, nutrient availability, sediment transport, biological activity, and the presence of inorganic and organic ligands. These factors can impact speciation, distribution between sediment and water phases, and cycling between inorganic and organic forms. Additionally, both HOCs' and organometals' biogeochemical behavior can result in strong sorption to solid surfaces, formation of stable complexes with organic matter, and bioaccumulation in the food chain.

Understanding fate and transport and the geochemical behavior of the site requires an evaluation of the partitioning of contaminants between the dissolved and particulate phases. Hence, the long-term water column sampling program should emphasize the collection of both dissolved phase and particulate phase COPCs and COPECs, under different hydrodynamic and hydraulic conditions. These data will support fate and transport model development and evaluations required to update the geochemical components of the conceptual site model.

Several sampling methodologies for HOCs are needed because the concentrations of select HOCs (*i.e.*, dioxin), particularly in the dissolved phase, are very low (parts per billion and in some cases parts per trillion). Each of these methodologies has associated uncertainties and the quality of the data obtained may be affected by shifts in HOC partitioning, the adsorption of HOCs to walls of the sampling containers, and the degree of HOC recovery in resin traps.

In order to address the complexities associated with low-level HOC sampling and analysis, and provide initial baseline water quality data to assess current-day levels of other target constituents (*e.g*, metals, conventional parameters) under varying hydrodynamic conditions, an initial sampling program is proposed. The objectives of this initial program are to:

1. Obtain a synoptic set of water column data on trace metals, methylmercury, TCL volatile and semivolatile organics, chlorinated herbicides and conventional parameters to update the CSM and calibrate the fate and transport model being developed for the restoration efforts. The sampling for trace metals, other than mercury, will use ultra-clean techniques in conformance with USEPA Method 1669. Sampling for mercury and methylmercury will use the ultra-clean aqueous sampling techniques.
2. Conduct a HOC sampling methodology validation study for the project. Section 6.1.1 "Sampling Methodologies Under Consideration for Water Column HOC"presents the different methodologies considered for this program. This validation study will answer the following questions:
   - What are the uncertainties associated with each HOC sampling methodology and which methodology best serves the project goals?
   - What are the effects of HOC phase shifts due to holding times and adsorption to the walls of the sampling containers?
3. Analyze the initial results of the above two sampling objectives and design a comprehensive long-term sampling program that will satisfy the data needs of the project. It is envisioned that the long term sampling program would be less broad and more focused than the short-term sampling program, once initial concentration patterns of COPCs and COPECs, as well as HOC sampling methodologies, are determined and validated.

6.1.1. Sampling Methodologies Under Consideration for Water Column HOC

A thorough "best practices" analysis for HOC water column sampling indicates three sampling methodologies offer scientific defensibility at reasonable costs: (1) intake pump/filtering system equipped with XAD^{tm} resin trap or similar sampling devices [*e.g.*, Infiltrex 300, Trace Organics Pollution Sampling (TOPS)] for the collection of discrete filtered samples (organics); (2) Niskin Bottles/20L Stainless Steel "Pop" Containers for collection of large volume samples for low to trace HOCs; (3) Semi-Permeable Membrane Devices (SPMDs) for collecting time-weighted average dissolved HOC concentrations. These methods are briefly described below.

The Infiltrex 300 is a commercialized version of the TOPS and available from Axys Technologies. It can operate from any water sampling platform and removes solids and HOCs/organometals from water samples (in the field) through the use of filters and XAD^{tm} traps. Although XAD^{tm} trap solids breakthroughs can occur when collecting samples over 20-30L, XAD^{tm} traps can be installed in series and analyzed separately to accommodate such samples. Most likely, a dedicated Infiltrex 300 would need to be maintained in a field sample processing facility or other controlled environment where power and other services are available (*i.e.*, anecdotal information indicates the Infiltrex is not robust enough to perform optimally on small boats). The Infiltrex 300 has been used for many years in multiple river systems (*e.g.*, Ohio River) similar in complexity to the Passaic River with great success. Procedures for the use of the Infiltrex 300 can be found in SOP 16 Infiltrex 300 Trace Organic Sampling in Attachment 1. It is the preferred system for water column sampling when field filtering is necessary.

Niskin bottles (10L) are weighted, water sample collection devices with triggered caps that can be remotely closed at a predetermined water column depth. They can be easily used to collect water samples across a river channel transect provided no field sample preparation is required. Generally, a composite of multiple samples are transferred into a 20L stainless steel pop container, which is transported in a cooler with ice to the analytical laboratory. Procedures to use Niskin bottles can be found in SOP 19 5-liter Niskin Bottle Use in Attachment 1. Niskin bottles, in conjunction with stainless steel pop containers, have been used with great success (*e.g.*, Delaware River Basin Commission program) when field filtering and sample preparation are not required.

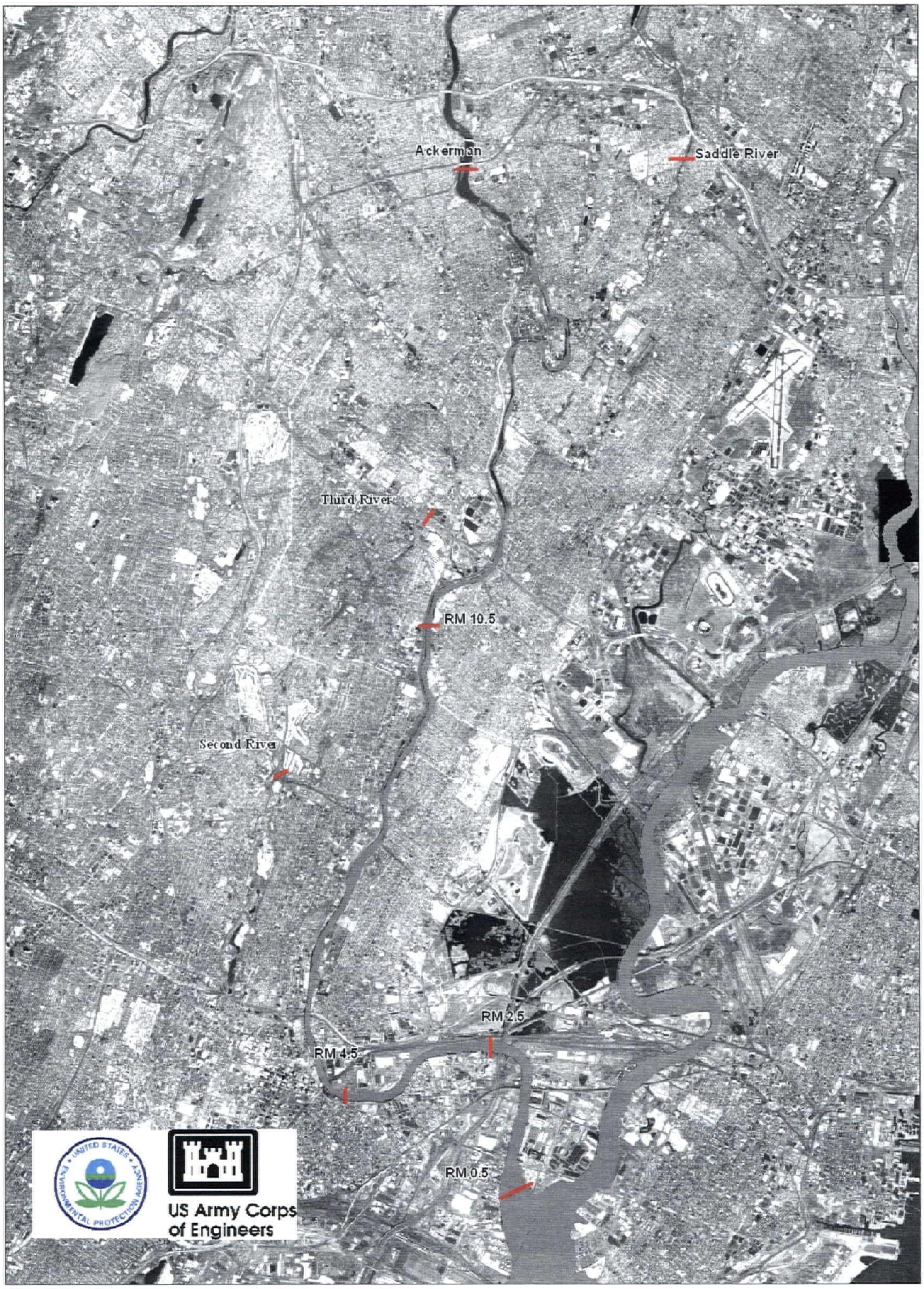
SPMDs are passive water column sampling units that are deployed for days to months. They estimate dissolved phase contamination based on lab-determined partitioning coefficients and sampling rates. SPMDs consist of a tubular, lay-flat, low-density polyethylene (LDPE) membrane containing a thin film of a high-molecular weight lipid (triolein). When placed in an aquatic environment, SPMDs accumulate HOCs and organochlorine pesticides. The LDPE tubing mimics a biological membrane by allowing selective diffusion of organic compounds into the sampling device. The passive HOC sampling is driven by membrane- and lipid-water partitioning. SPMD is a useful technique for establishing temporally averaged spatial trends in dissolved organic contaminants. Because it is a semi-quantitative technique, it does not provide direct measurements of concentration, but it can be used to compare the relative concentration among the stations (assuming turbulence, temperature, etc., are uniform). Bio-fouling is likely an issue, as are variable sampling rates in differing salinities and under differing flow conditions. The procedure for using SPMDs is described in SOP 17 Procedure for Deployment and Retrieval of Semipermeable Membrane Devices in Attachment 1. SPMDs have been used successfully in the Columbia River for monitoring low-level HOCs.

6.2. TIDAL WATER COLUMN SAMPLING SCOPE

To satisfy the objectives of the short-term water column program, an initial monitoring program over a two month period is planned. The program will involve conducting sampling at the following locations:

- RM 0, the entrance to Newark Bay. This is the down-estuary end of the salt wedge, and in the brackish section of the CSM.
- RM 2.5, a salt-wedge station, above known contaminated sediment areas in Harrison Reach, in the brackish section of the CSM.
- RM 4.5, a salt-wedge station, down-estuary of combined sewer overflows near Newark, in the brackish section of the CSM.
- RM 10.5, down-estuary of Third River, in the transitional zone of the CSM.
- RM 17 at the Ackerman Bridge, close to the head of tide and the Dundee Dam boundary, in the freshwater zone of the CSM.
- The head of tide of the major tributaries to the Lower Passaic River including the Saddle River, Second River, and Third River.

These sampling locations are shown on Figure 6-1. Note that some of the proposed sampling will only be conducted at selected stations. Each sampling methodology will be implemented with quality control including field blanks, replicates, and spikes. The analysis related to the HOC sampling methodology validation study will be performed by the same laboratory. A separate program to determine COPC and COPEC loads at the head of tide of the major tributaries is planned for 2006 (see Section 7). The following sections provide an overview of the initial sampling program.



Approximate Sampling Location

N

7,500 3,750 0 7,500 Feet

MALCOLM PIRNIE

Lower Passaic River Superfund Site
Water Column Sampling Locations

Figure 6-1

Map Document: (P:\0285924\Mapping\Small Volume Water Column\sampling locations areal photo.mxd) 1/9/2006

6.2.1. Time-Weighted Average Samples

Time-weighted average (TWA) samples will be collected from all sampling locations identified above using SPMDs (see SOP 17 in Attachment 1). At each location, SPMDs will be placed approximately 2 feet below the water surface. Additional SPMDs will be placed approximately 2 feet above the river bottom at RM 0, 2.5 and 4.5 to capture the stratification effects of the salt or brackish water. After 28 days, SPMDs will be collected and replaced with fresh SPMDs. The retrieved SPMDs will be packaged and shipped to the specialty subcontractor for sample preparation and extraction; all chemical analysis on the extract will be conducted by the same subcontractor laboratory. SPMDs will be used to estimate time-weight-averaged concentrations and bioconcentrations of trace HOCs such as PCBs, PAHs, dioxins, and pesticides. The SPMD data will be used to screen for the presence of certain HOCs in the tributaries and to compare the relative fingerprints of the HOCs in the different locations. Note that the SPMDs will not be used in the HOC sampling methodology validation study because this sampling methodology provides estimates of the dissolved phase HOC concentrations only.

6.2.2. Small-Volume Composite Grab Samples

Small volume (1-5 liters; see SOP 18 Small Volume Grab Water Samples and Cross-sectional Composite Sample Procedure in Attachment 1) water column composite grab (SVCG) samples will be collected from all SPMD locations. These small-volume samples will be analyzed for TAL metals, mercury and methylmercury, TCL volatile and semivolatile organics, chlorinated herbicides, and conventional and eutrophication model parameters [TSS, POC, DOC, particle size distribution, BOD, COD, Total Kjeldahl Nitrogen, Chlorophyll A, and total and orthophosphate ammonia] at each SPMD station. Field parameters, including temperature, pH, dissolved oxygen (DO), conductivity, and secchi disk, will also be monitored (see SOP 21 Horiba Use for Measuring Water Parameters and SOP 23 Secchi Disk Depth (Transparency) Measurement in Attachment 1). Samples will be collected at the same times at each of the tidally influenced stations, and the tidal stage and hydrodynamic conditions of the river will be noted. At each location, multiple small volume grabs will be collected across a river transect consisting of three to five sites per transect. With the exception of the samples collected for TSS analysis, all other transect grabs samples will be composited to represent the cross-section, managed/preserved as required, and shipped to the lab on the day of collection. A staff gage will be installed at each transect so that tide-height can be recorded when samples are collected.

6.2.3. HOC Sampling Methodology Validation Study

The HOC Sampling Methodology Validation Study (HSMVS) will be conducted at stations located at RM 2.5 and RM 10.5 after the SVCG sample collection. The HSMVS will:

- Use an Infiltrex 300 or similar large volume sampler to obtain particulate phase and XAD^{tm} trap dissolved phase samples (See SOP 16 Infiltrex 300 Trace Organic Sampling in Attachment 1).
- Collect representative large volume samples (~20L) and filter them immediately in the field (See SOP 16 Infiltrex 300 Trace Organic Sampling in Attachment 1). This may be conducted by using the Infiltrex to obtain the particulates. Pre-cleaned stainless steel pop bottles will be used to contain the filtrate. The XAD traps will not be used.
- Collect representative large volume whole water (~20L) using 10L Niskin bottles or similar clean sampling devices. The samples will be transferred on site to pre-cleaned stainless steel pop bottles, as previously used in the Delaware River Basin Program, and which will be immediately shipped to the lab for filtering and analysis (See SOP 19 5-liter Niskin Bottle Use in Attachment 1).

The sampling for this study will be conducted during ebb tide during the first month and flood tide during the second month, under high and low particulate or river flow conditions to reflect different flow/particulate concentrations. Samples for all three validation study programs will be done at the same time over a two-day period. Sampling on the first day of the HSMVS program will be done at river mile 2.5, and on the second day sampling will be done at RM 10.5. During each day of sampling a separate 5-liter whole water column sample will also be collected for analysis for TSS, POC and DOC, and PAHs. Conventional and hydrodynamic parameters including DO, conductivity, temperature, and pH will be monitored during the sampling period.

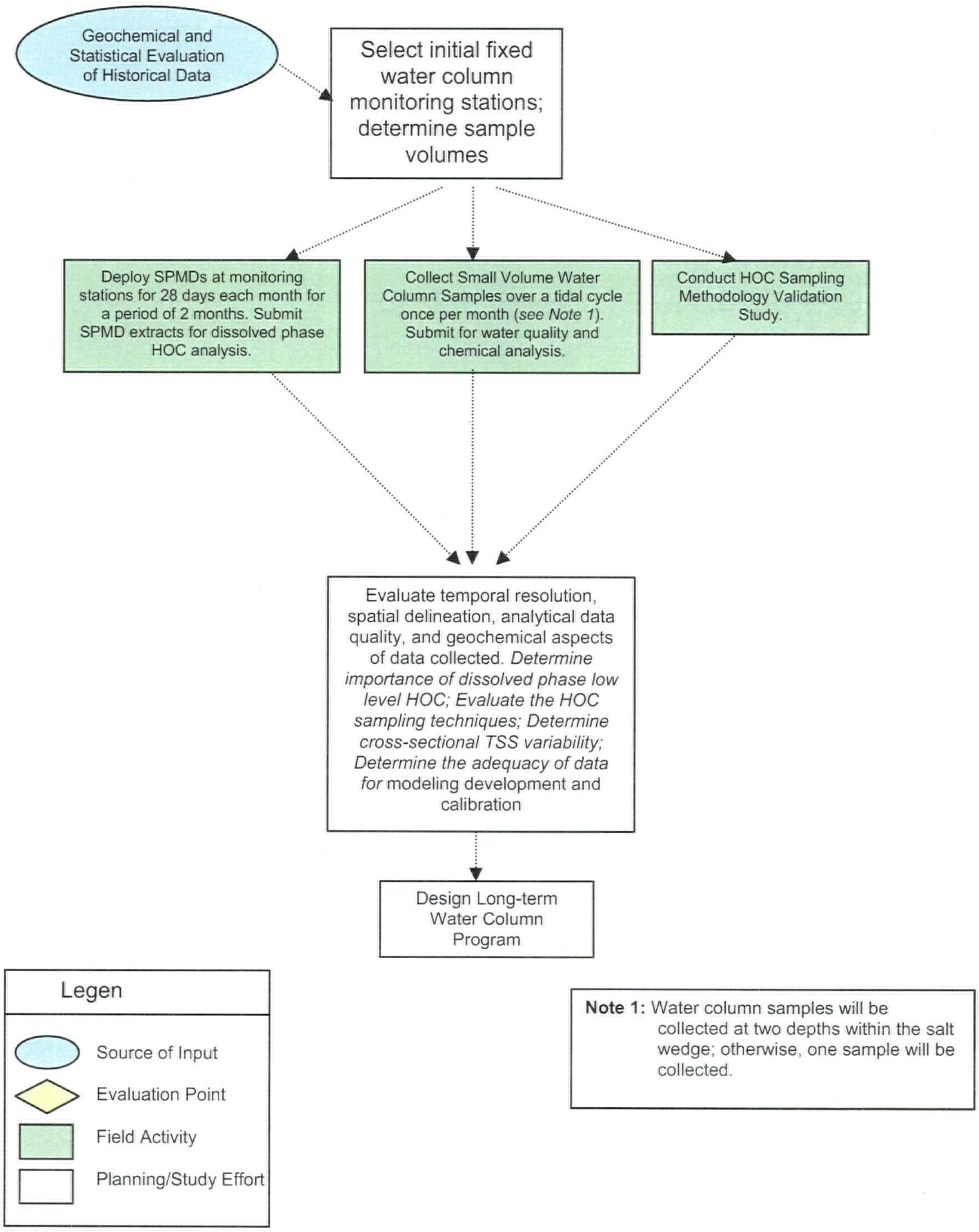
6.3. WATER COLUMN SAMPLE COLLECTION AND PROCESSING

A summary of the water column field activities, listed in the order in which they will be performed each month, is presented in Table 6-1. These methods will be evaluated in the field to assure that they are practical and are achieving the necessary results. A decision strategy is presented in Figure 6-2. If more efficient methods are identified, any modifications made after the first month of sampling will be submitted as an addendum to the water column program.

Table 6-1: Initial Water Column Sampling Activities

Task	Location	Sampling Time	No. of Samples/Month
Deploy 4 SPMDs	In the vicinity of (RM) 0, 2.5, 4.5, 10.5. At RM 0, 2.5 and 4.5 near water surface and near river bottom.	SPMDs will be deployed for a period of 28 days.	7 plus Quality Assurance/Quality Control (QA/QC).
Deploy 4 SPMDs	Head of tide at Dundee Dam and each major tributary (*i.e.*, 2nd River, 3rd River, and Saddle River).	SPMDs will be deployed for a period of 28 days.	4 plus QA/QC.
Collect SVCG samples	RM 0, 2.5, 4.5 10.5. At RM 0, 2.5 and 4.5 near water surface and near river bottom. Cross-sectional composite at transect of 3 to 5 stations.	- 1st month every 2 hours during ebb tide. - 2nd month every 2 hours during flood tide.	21 whole water plus QA/QC. 21 filtered water samples for metals. 29 samples plus QA/QC for TSS.
	Head of tide at Dundee Dam and each major tributary (*i.e.*, 2nd River, 3rd River, and Saddle River). Cross-sectional composite at transect of 3 to 5 stations.	Collect samples just before the 2 hour SVCG ebb tide sampling at Tidal Locations.	4 plus QA/QC. 4 filtered water for metals. 20 samples plus QA/QC for TSS.
Collect HSMVS: - Infiltrex - Large Volume Processed - Large Volume Whole Water	RM 2.5 and RM 10.5. At RM 2.5 near water surface and near river bottom.	- 1st month during Ebb tide. - 2nd month during flood tide.	6 plus QA/QC.

Figure 6-2: Decision Strategy for 2005 Initial Tidal Water Column Sampling Efforts



7.0 TRIBUTARY AND HEAD-OF-TIDE WATER COLUMN SAMPLING (TO BE ADDED IN 2006)

7.1. DATA NEEDS AND SAMPLING OBJECTIVES

7.2. TRIBUTARY WATER COLUMN SAMPLING PROGRAM SCOPE

7.3. TRIBUTARY WATER COLUMN SAMPLE COLLECTION AND PROCESSING

8.0 POREWATER AND GROUNDWATER SAMPLING (TO BE ADDED IN 2006)

8.1. DATA NEEDS AND SAMPLING OBJECTIVES

8.2. POREWATER SAMPLING SCOPE

8.3. POREWATER SAMPLE COLLECTION AND PROCESSING

9.0 MUDFLAT SEDIMENT SAMPLING (TO BE ADDED IN 2006)

9.1. DATA NEEDS AND SAMPLING OBJECTIVES

9.2. MUDFLAT SEDIMENT SAMPLING SCOPE

9.3. MUDFLAT SEDIMENT SAMPLE COLLECTION AND PROCESSING

10.0 LONG-TERM TIDAL WATER COLUMN SAMPLING (TO BE ADDED IN 2006)

10.1. DATA NEEDS AND SAMPLING OBJECTIVES

10.2. LONG TERM TIDAL WATER COLUMN SAMPLING SCOPE

10.3. TIDAL WATER COLUMN SAMPLE COLLECTION AND PROCESSING

11.0 ACRONYMS

ADCP	Acoustic Doppler Current Profiler
BAZ	Biologically Active Zone
Be-7	Beryllium-7
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	Centimeter
COD	Chemical Oxygen Demand
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
Cs-137	Cesium-137
CSM	Conceptual Site Model
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	4-4'-Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DQO	Data Quality Objective
EM	Engineering Manual
ERDC	Engineer Research Development Center
FS	Feasibility Study
FSP	Field Sampling Plan
Ft.	Feet
GIS	Geographical Information system
GPS	Global Positioning System
HASP	Health and Safety Plan
HOC	Hydrophobic Organic Compound
HSMVS	HOC Sampling Methodology Validation Study
IDW	Investigation-Derived Waste
L	Liter
LDPE	Low-density Polystyrene
LISST	Laser In-Site Scattering and Transmissometry
MPI	Malcolm Pirnie, Inc.
NA	Not Applicable
NGVD29	National Geodetic Vertical Datum, 1929
NIOSH	National Institute for Occupational Safety and Health
NJADN	New Jersey Atmospheric Deposition Network
NJDEP	New Jersey Department of Environmental Protection
NJDOT-OMR	New Jersey Department of Transportation – Office of Maritime Resources

NRDA	Natural Resource Damage Assessment
OBS	Optical Backscatter Sensor
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
Pb-210	Lead-210
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzodioxins
PCDD/F	Polychlorinated Dibenzodioxins/Furans
POC	Particulate Organic Carbon
PREmis	Passaic River Estuary Management Information System
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
RM	River Mile
SOP	Standard Operating Procedure
SPI	Sediment Profile Imagery
SPMD	Semi-Permeable Membrane Devices
SSS	Side Scan Sonar
SVCG	Small Volume Composite Grab
TAL	Target Analyte List
TCDD	Tetrachlorodibenzodioxin
TCL	Target Compound List
Th-234	Thorium 234
TOPS	Trace Organic Platform Sampler
TSI	Tierra Solutions, Inc.
TSS	Total Suspended Solids
TWA	Time Weighted Average
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
WRDA	Water Resources Development Act
XRF	X-Ray Fluorescence

12.0 REFERENCES

Aqua Surveys, Inc. 2005. Technical Report, Geophysical Survey, Lower Passaic River Restoration Project. Draft, August 2005

Bopp, R.F., M.L. Gross, H. Yong, H.J. Simpson, S.J. Monson, B.L. Deck, F.C. Moser, 1991. A Major Incident of Dioxin Contamination: Sediments of New Jersey Estuaries. Environmental Science and Technology, Volume 25, No. 5, pp. 951-956, 1991.

Boudreau, B.P. 1998. "Mean Mixed Depth of Sediments: The Wherefore and the Why." *Limnol.Oceanogr., 43*(3): 524-526.

Clarke, D., M. Palermo, and T. Sturgis. 2001. "Subaqueous Cap Design: Selection of Bioturbation Profiles, Depths, and Rates." DOER Technical Notes Collection (ERDC TN-DOER-C21), U.S. Army Engineering Research and Development Center, Vicksburg, MS.

Dyer A.R., *et al.* 1996. A comparison of in situ techniques for estuarine floc settling velocity measurements. Journal of Sea Research 36 (1/2): 15-29.

Eisma D. *et al.* 1996. Intercomparison of in situ suspended matter (floc) size measurements. Journal of Sea Research 36 (1/2): 3-14.

Fugate, D.C, C.T. Friedrichs. 2002. Determining concentration and fall velocity of estuarine particle populations using ADV, OBS and LISST. Continental Shelf Research 22: 1867-1886.

Gigliotti, Cari L., *et al.* 2005. Atmospheric concentrations and deposition of polycyclic aromatic hydrocarbons to the Mid-Atlantic east coast region. Environmental Science Technology 2005, 39, 5550-5559.

Gioia, Rosalinda, *et al.* 2004. Atmospheric concentrations and deposition of organochlorine pesticides in the US Mid-Atlantic region. Atmospheric Environment 39 (2005) 2309-2322.

Gotthard, D., 1998. Three-Dimensional, Non-Destructive Measurements of Sediment Bulk Density Using Gamma Attenuation. Report, Department of Mechanical and Environmental Engineering, University of California, Santa Barbara, CA 93106.

Jepsen, R., J. Roberts, W. Lick. 1997. Effects of bulk density on sediment erosion rates. Water, Air, and Soil Poll., Vol. 99, pp. 21-31.

Malcolm Pirnie, Inc. 2005a. Quality Assurance Project Plan, Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and Hydroqual, Inc. August 2005.

Malcolm Pirnie, Inc. 2005b. Field Sampling Plan: Volume 3, Lower Passaic River Restoration Project. Revised Preliminary Draft. Prepared in conjunction with TAMS, *an Earth Tech company* and Greeley Polhemus Group, Inc. August 2004; geophysical program as amended July 2005.

Malcolm Pirnie, Inc. 2005c. Work Plan, Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and Hydroqual, Inc. August 2005.

Malcolm Pirnie, Inc. 2005d. Health and Safety Plan, Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and HydroQual, Inc. January 2005.

McNeil, J., C. Taylor, W. Lick. 1996. Measurements of the erosion of undisturbed bottom sediments with depth. J. Hydraul. Eng. – ASCE, 122(6), 316-324.

Roberts, J., R. Jepsen, D. Gottard, W. Lick. 1998. Effects of particle size and bulk density on erosion of quartz particles. J. Hydraul. Eng. – ASCE, 124(12), 1261-1267.

Sanford, L.P., J.P.-Y Maa,., 2001. A unified erosion formulation for fine sediments. Marine Geology, 179(1-2): 9-23.

Sanford, L.P., S.E. Suttles, J.P. Halka. 2001. Reconsidering the physics of the Chesapeake Bay Estuarine Turbidity Maximum. Estuaries, 24(5): 655-669.

TAMS/Earth Tech, Inc. and Malcolm Pirnie, Inc. 2005. Restoration Opportunities Report.

Totten, Lisa A., *et al.* 2004. Atmospheric concentrations and deposition of polychlorinated biphenyls to the Hudson River estuary. Environmental Science Technology. 2004, 38, 2568-2573.

USACE, 2004. Bathymetric Survey. Prepared by Rogers Surveying, P.L.L.C for the USACE in September-November 2004.

USEPA, 2004. Contract Laboratory Program Guidance for Field Samplers. 2004.

Attachment 1
Standard Operating Procedures

FIELD SAMPLING PLAN VOLUME 1 – version 2006-01-11
LOWER PASSAIC RIVER RESORATION PROJECT

ATTACHMENT 1 – Standard Operating Procedures

- SOP 4: Locating Sample Points Using a Global Positioning System (GPS)
- SOP 5: Documenting Field Activities
- SOP 6: Decontamination of Soil Sampling Equipment
- SOP 7: Decontamination of Water Sampling Equipment
- SOP 8: Sediment Probing
- SOP 9: Vibracoring – Collecting High and Low Resolution Cores
- SOP 10: Split Spoon Sample Collection
- SOP 11: Core Processing – High Resolution
- SOP 12: Core Processing – Low Resolution
- SOP 13: Sediment Collection Using Hand Coring Devices
- SOP 14: X-radiograph Procedures – (to be added)
- SOP 15: Density Profiler Procedures – (to be added)
- SOP 16: Infiltrex 300 Trace Organic Sampling
- SOP 17: Deployment and Retrieval of Semipermeable Membrane Devices
- SOP 18: Small Volume Grab Water Samples and Cross-sectional Composite Sample Procedure
- SOP 19: 5-liter Niskin Bottle Use
- SOP 20: Ultra-clean Water Sampling Procedures for Mercury
- SOP 21: Horiba Use for Measuring Water Parameters
- SOP 22: Management and Disposal of Investigation Derived Waste
- SOP 23: Secchi Disk Depth (Transparency) Measurement
- SOP 24: Eckman Dredge

Note: SOPs 1, 2, and 3 are found in the Quality Assurance Project Plan (Malcolm Pirnie, 2005a)

Title: Locating Sample Points Using a Global Positioning System (GPS)

I. Purpose

The purpose of this procedure is to provide reference information for the documentation of sample locations using a GPS at the Lower Passaic River Restoration Project Superfund Site.

II. Definitions

1. GPS - The GPS is a satellite-based positioning system, operated and controlled by the U.S. Department of Defense. The GPS includes 24 satellites, and can be used by anyone who has a GPS receiver. The GPS receiver is used for position determination, navigation, and survey tasks on land, sea, and in the air. The method of utilizing GPS varies with each application and the type of GPS equipment used. Operating methods range from low precision, code phase systems to highly accurate, carrier phase systems that facilitate on-the-fly measurements, also known as real-time kinematic surveying (RTK). The Lower Passaic River Restoration Project Superfund Site will use a hand held GPS receiver with sub meter horizontal accuracy to capture the coordinates of sample locations.

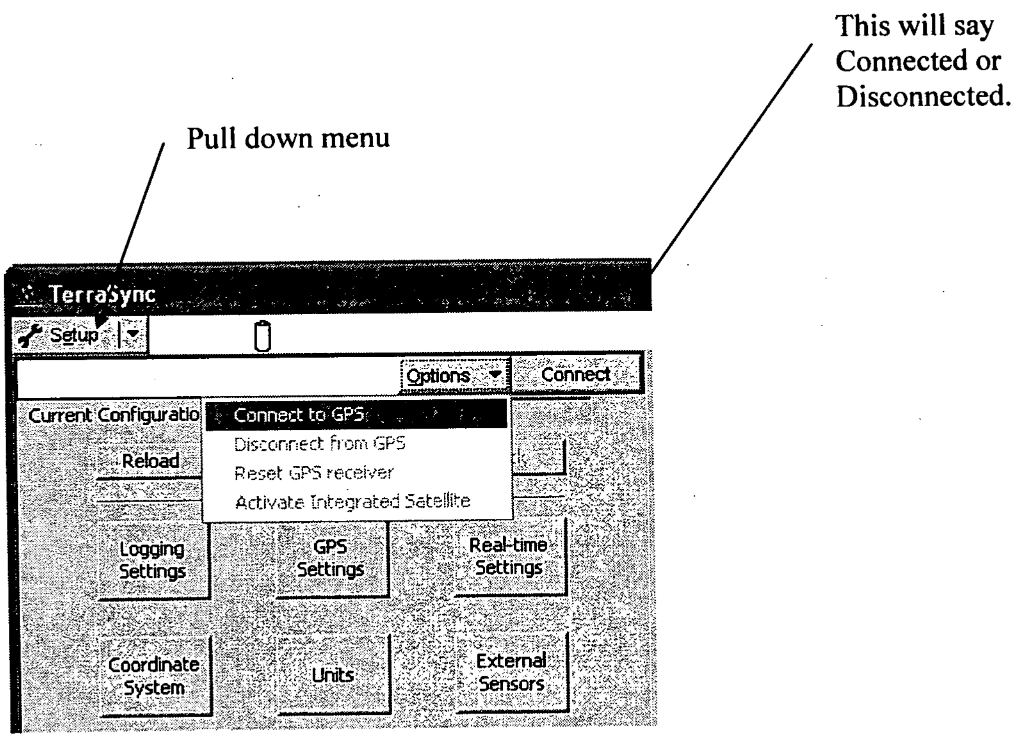
III. Equipment and Materials

1. Trimble Geo XT with related cable and power supply.

IV. Field Procedure

1. Getting Started

   A. Power up the unit by pressing the large gray button below the screen area and start the TerraSync application by selecting F1 or the Terra Sync icon. Wait about 5 minutes for the GPS unit to receive a new almanac and satellite information.
   B. Verify that the GPS unit is connected to the satellite network. After starting TerraSync, the status screen will appear, and will indicate if the GPS is connected or disconnected to the satellite network. If it is disconnected, use the stylus to click on the pull down menu in the upper left corner of the screen (see graphic below) and go to the Setup screen. Underneath the Setup pull down menu, select Options and select Connect to GPS.



2. Confirm Status of GPS

   A. The GeoXT will be collecting a new almanac and satellite readings. In the top tool bar you will see the number of satellites tracking, differential correction signal status, and the battery charge information. You must have 4 satellites available and the differential status must be on (i.e. the differential icon should not be blinking) to collect coordinate locations.

Satellites Tracking
Differential Correction Status
Battery Charge Indicator

3. Confirm the Coordinate System

   A. In the Setup menu choose Coordinate System
   B. On this screen you should see the following, or update entries to match:
      System = US State Plane 1983
      Zone = New Jersey 2900
      Altitude = Mean Sea Level (MSL)
      Altitude Units = Feet
      Geoid = DMA 10x10 (Global)
      Coordinate Units = Meters
      Display USNG = Off

4. Create a File

   A. From the pull down menu in the upper left corner choose Data
   B. Select the Dictionary Named Passaic and name the file using the input panel (if the input panel is not automatically present click on the icon in the lower right corner that looks like a key board)
   C. Click Create

5. Collecting Point Data

   A. Using the pull down menu choose Map (you can also collect data from the Data menu but you will not see where you are on the map).
   B. Click on the blue circle in the upper right corner of the screen enter the name of the sample you are taking as well as the matrix (sediment or water).
   C. You can insure you are collecting satellite data by seeing a pen and wavy line icon to the right of the main pull down menu. You will also see the number of data sets you have gathered, the number of satellites that you are collecting information from and the status of the differential correction.
   D. When you have collected more than 3 sets of data (indicated by the number next to the pen and wavy line icon) select OK.
   E. You should now see your collected data as a square with an X in it on the map.
   F. Move to you new location and repeat step 5 until you are finished.

6. Closing the data and shutting down

   A. When you are finished using the GPS unit shut the application down by clicking the X in the upper right corner of the screen.
   B. You will be asked if you are sure you want to do this. Click yes.
   C. Press the gray button at the bottom of the GeoXT and bring it back to the office for processing.

V. Quality Control

The GPS has quality control features that are built into the system. The system will not allow measurements to be taken if there are not enough satellites available to provide accurate readings, if the satellite geometry is not conducive to the survey, and for other reasons. The system maintains quality control records during a survey that contain information about the quality of the GPS position, including the number of available satellites, satellite geometry, and horizontal and vertical precision levels. These records can be accessed when the data is post processed in order to assure that the necessary quality standards are being achieved.

VI. Reference

TerraSync Operation Guide. Trimble Navigation Ltd., 2002.

Title: Documenting Field Activities

I. Introduction

The purpose of this guide is to provide reference information regarding the documentation of field activities conducted at the Lower Passaic River Restoration Project Superfund Site.

II. Definitions

1. Field Data – Any and all information collected during activities at the site.

2. Electronic Field Data Form – A standardized electronic data form used for the collection of information and/or technical data during field activities.

III. Guidelines

The documentation of field activities at uncontrolled hazardous waste sites is governed by a variety of legal guidelines that must be understood prior to the commencement of field activities. It is imperative that the personnel who will be conducting the field activities understand how the overall constitutional, statutory, and evidentiary legal requirements apply to the site inspection documentation and to the rights of potentially responsible parties.

The description of and observations made during field activities often provide the basis for technical site evaluations and other related written reports. All electronic records and notes generated in the field will be considered controlled evidentiary documents and may be subject to scrutiny in litigation. Consequently, it is essential that the Field Team Leader pay attention to detail and document to the greatest extent practicable every aspect of the inspection.

Personnel designated as responsible for the documentation of field activities must be aware that all electronic notes taken may provide the basis for the preparation of responses to legal interrogatories.

Field documentation must provide sufficient information and data to enable the reconstruction of field activities. A wireless field application using standardized electronic data forms will provide the basic means for documenting field activities.

Control and maintenance of wireless field applications used in documentation of field activities is the responsibility of the Field Team Leader. If the person responsible for documenting site inspection activities is someone other than the Field Team Leader, the transfer of responsibility must be documented.

1. Documentation of Field Activities

Electronic field entries must provide an unbiased, concise, and detailed description of all field activities. Step-by-step instructions and procedures for documenting field activities are provided below. They are organized by the following:

A. The first set of instructions and procedures provides general guidance relating to the format and technique in which electronic field entries are to be made. It is important that field activities are documented in the most organized, chronological manner possible.

B. The second set of instructions and procedures provide guidance on the type of information to be recorded when field activities are electronically documented. In general, the following information must be recorded:

i. The identities and affiliation of the personnel conducting field activities.

ii. A description of the type of field work being conducted (*e.g.*, water column sampling, sediment core collection, etc.) and the equipment used.

iii. The date and time the field activities were conducted, with specific temporal information for each task (*e.g.*, record the time activities commenced at each individual location, or when different types of activities commenced at the same location), if applicable.

iv. The site where the field activities were conducted, and also any individual location within that site where work was performed (*e.g.*, specific sampling sites).

v. The general methodology used to conduct the activities.

vi. Deviations from FSP or SOP and reason for change

C. Instruction and procedures relating to the format and technique in which electronic field entries are to be performed should conform to the following:

i. Each day field activities are conducted the date, time, site name, location, names of Malcolm Pirnie personnel and their responsibilities, and names of non-Malcolm Pirnie personnel into the field application. Any deviations from the work plan that occur while field activities are being conducted must also be documented.

ii. All photos taken must be associated with field entries and all photo locations must be referenced on a site map. Information in the photo log must include the date, time, photographer, and a description.

iii. All entries must be made in language that is objective, factual, and free of personal feelings or other terminology that might prove inappropriate.

iv. All entries must be accompanied by the appropriate 24-hour clock time (such as 1530 instead of 3:30). A time and status entry is recommended every 30 minutes or less.

v. If the individual designated for field documentation tasks transfers those tasks to another team member, he or she must clearly document this transfer of responsibility through logging out and the newly designated field member log back in with their assigned login and password.

2. Sampling Activities

A chronological record of each sampling activity must be kept. During sampling, the data entry person will choose the appropriate survey that the sampling falls under (*i.e.*, large volume water column sampling, high resolution coring, *etc.*). The field application will automatically prompt the user for required data and attributes based on pre-programmed survey requirements. Be sure that all required fields are properly filled in or field application will not allow user to continue. Container IDs are pre-printed and need to be affixed and entered into the field application for every sample. After data entry is complete for the day user accesses the shipping module and designates which coolers contain which samples and to where the samples are to be shipped. The generated sample ID labels should be printed out and affixed to the appropriate sample container. Print out generated chain of custody to accompany samples in shipment.

IV. References

U.S. EPA-Characterization of Hazardous Waste Sites - A Methods Manual, Volume I - Site Investigations, April 1985:

USACE Requirements for the Preparation of Sampling and Analysis Plans, September 1, 1999

Procedure No.: SOP-6
Date: August, 2005
Revision No. 3
Prepared by: John Hardin (Battelle)
Reviewed by: John Logigian

Title: Decontamination of Soil Sampling Equipment

I. Introduction

This procedure describes the methods used to decontaminate soil sampling equipment and sample processing tools used at the Lower Passaic River Superfund Site. The procedures specifically address equipment used to collect sediment and soil samples.

II. Definitions

PPE-Personal Protective Equipment

III. Equipment and Supplies

The following equipment will be used to decontaminate equipment and tools used to collect sediment and soil samples:

1. Tap water for initial cleaning and rinsing of equipment.
2. De-ionized water for final rinsing of equipment after tap water or solvent rinse.
3. Non-phosphate detergent (*e.g.* Alconox™) for cleaning equipment.
4. Dishwashing detergent (*e.g.* Joy™ which provides suds in seawater) to remove oily or organic residue.
5. Nitric acid as a 10% solution for removing metal contaminants from equipment
6. Organic solvent for final cleaning of equipment (*e.g.* hexane)
7. Personnel protective equipment (PPE) - including disposable gloves (nitrile preferred), disposable wipes, eye wash system, first aid kit, and waterproof outerwear (if necessary).
8. Re-sealable buckets approved for waste collection and transportation.
9. Squirt bottles for water, alcohol, and solvents.
10. Brushes for cleaning equipment.
11. Field notebooks, pens, pencils, and digital camera to document decontamination procedures.

IV. Guidelines

The following equipment will be used to collect sediment cores and require decontamination:

1. Rotary drilling rig (truck-mounted or skid type) sampling equipment (e.g., split spoons). Large drilling equipment (*e.g.,* tri-cone bits, casing, augers, rods, etc.) will be steam-cleaned only.
2. Tripod drill – follow procedures for drill rig above.
3. Calibrated Steel Rod to investigate the sediment type and probe the depth of unconsolidated sediments at a sampling location and to determine the length of tubing to use.
4. Shelby tubes conforming to thin-walled tube specifications outlined in ASTM D 1587 with a 3-inch O.D.
5. Vibracorer and ancillary equipment.
6. Aluminum, Polycarbonate, Lexane, or Cellulose Acetate Butyrate (CAB) Tubing of appropriate diameter (approximately 3.75 inch O.D. and 0.07 inch wall thickness) for use with the vibracoring apparatus.
7. Sediment Grab Sampler (*e.g.,* Ponar, van Veen, Smith McIntire, or Eckman Grabs) used for surface sediment collection.
8. Stainless steel scoops, spoons, bowls, and other equipment that come into contact with the sample, are used for homogenization, or are used to segment core tubes.

Collection of sediment, soil, and water samples for chemical analysis requires that the equipment be cleaned between sample locations to avoid sample contamination. Generally, the cleaning procedures to be followed between sample locations are as follows:

Decontaminate all sample collection tools that contact the sample as well as all bowls and mixing/distribution implements in accordance with the following procedures.

1. Rinse each item with tap water to remove mud, dirt, or other visually present material.
2. Scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent (*e.g.* Joy™) for items with oily or other sticky organic residue.
3. Rinse the item with tap water to remove all residual soap
4. Rinse the item with 10% nitric acid to remove residual metals
5. Rinse the item with de-ionized water
6. Rinse the item with organic solvent (*e.g.* hexane)
7. Rinse the item with de-ionized or analyte-free water and allow to air dry.

8. Wrap the item(s) in aluminum foil or plastic bag to protect it until it is used.

All solvents must be captured and disposed of in appropriate, labeled, aqueous waste containers. All instruments that come into contact with the sample (i.e. syringe, ruler, collection buckets) must be cleaned in the same manner as the sampling device. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream. Staff performing decontamination procedures need to wear appropriate PPE, gloves (*e.g.* nitrile) and eye protection. Care must be taken in cleaning not to allow contact of cleaning solutions with clothing as much as possible. If circumstances dictate contact will occur (*e.g.* high pressure washing, splashing, high wind), waterproof outer clothing must be worn (*e.g.* foul weather gear or rain gear).

Decontamination procedures may vary depending on specific workplan specifications, and unique contaminants of concern at specific locations. The project workplan may designate collection of equipment rinse samples to document effectiveness of cleaning.

This SOP does not address radioactive decontamination, PPE for radioactive waste, or disposal of radioactive contaminated waste material.

IV. References

American Society for Testing and Materials (ASTM), 1994. Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. Designation: D 5088 – 90.

Title: Decontamination of Water Sampling Equipment

I. Introduction

This procedure describes the methods used to decontaminate water sampling equipment and sample processing tools for the Lower Passaic River Restoration Project. The procedures specifically address equipment used to collect sediment samples.

II. Definitions

PPE - Personal Protective Equipment

III. Equipment and Supplies

The following equipment will be used to decontaminate equipment and tools used to collect water samples:

1. Tap water for initial cleaning and rinsing of equipment.
2. De-ionized water for final rinsing of equipment after tap water or solvent rinse.
3. Non-phosphate detergent (*e.g.*, Alconox™) for cleaning equipment.
4. Dishwashing detergent (*e.g.*, Joy™ which provides suds in seawater) to remove oily or organic residue.
5. Nitric acid as a 1% solution for removing metal contaminants from equipment
6. Isopropyl alcohol
7. Organic solvent for final cleaning of equipment (*e.g.*, hexane or equivalent)
8. Personnel protective equipment (PPE) - including disposable gloves (Nitrile preferred), disposable wipes, eye wash system, first aid kit, and waterproof outerwear (if necessary).
9. Re-sealable buckets approved for waste collection and transportation.
10. Squirt bottles for water, alcohol, and solvents.
11. Brushes for cleaning equipment.
12. Field notebooks, pens, pencils, and digital camera to document decontamination procedures.

IV. Guidelines

The following equipment will be used to collect water samples and require decontamination:

1. Infiltrex 300 Trace Organic Sampler: Pump, integral piping and other surfaces associated with the Infiltrex 300 Trace Organic Sampler's operation.
2. 5L Niskin bottles or equivalent.
3. Stainless Steel pressurized POP Canister
4. Vapor traps
5. Plastic tubing
6. Funnels
7. Graded cylinders
8. Graded tools used to measure river depth
9. Other equipment that comes into contact with the sample (*e.g.*, buckets, etc.).

Collection of water for laboratory analysis requires that the equipment be cleaned between sample locations to avoid sample contamination. Generally, the cleaning procedures to be followed between sample locations are as follows:

Decontamination: all sample collection tools that contact the sample as well as all bowls and mixing/distribution implements in accordance with the following procedures.

1. Disassemble item (except for Stainless Steel POP bottles and 5L Niskin or equivalent bottles at this stage).
2. Rinse each item with tap water.
3. For Stainless Steel POP Canister and 5L Niskin bottles (or equivalent): pour approximately 1 liter of non-phosphate detergent such as Alconox™ and lay on its side for at least 2 hours (roll the canister periodically to contact all interior surfaces.
4. Scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent (*e.g.*, Joy™) for items with oily or other sticky organic residue. Prior to scrubbing, disassemble stainless steel containers, 5L Niskin bottles or equivalent, etc. Be sure to scrub the inside of canisters, bottles, etc. (inside and out), threads, cover bucket, etc. Soak stainless steel containers, 5L Niskin bottles or equivalent, etc. for 30 minutes to 1 hour; roll bottle frequently.
5. During the scrubbing process, be sure to bleed Alconox™ solution or equivalent through small passageways/nozzles/vents, etc.
6. Rinse the item with tap water to remove all residual soap. Be sure to bleed tap water through small passageways/nozzles/vents, etc.

7. Rinse the item with 10% nitric acid to remove residual metals. Be sure to bleed 10% nitric acid through small passageways/nozzles/vents, etc.
8. Rinse the item with de-ionized water. Be sure to bleed de-ionized water through small passageways/nozzles/vents, etc.
9. Rinse the item with isopropyl alcohol. Be sure to bleed isopropyl alcohol through small passageways/nozzles/vents, etc.
10. Rinse the item with de-ionized water. Be sure to bleed de-ionized water through small passageways/nozzles/vents, etc.
11. Rinse the item with organic solvent (*e.g.*, hexane or equivalent). Be sure to bleed organic solvent through small passageways/nozzles/vents, etc.
12. Rinse the item with de-ionized or analyte-free water and allow to air dry. Be sure to bleed de-ionized or analyte-free water through small passageways, nozzles, vents, etc.
13. Re-assemble item(s).
14. Wrap the item(s) in aluminum foil or plastic bag to protect it until it is used.

All solvents must be captured and disposed of in appropriate, labeled, aqueous waste containers. All instruments that come into contact with the sample water must be cleaned in the same manner as the sampling device. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream. Staff performing decontamination procedures need to wear appropriate PPE, gloves (*e.g.*, Nitrile) and eye protection. Care must be taken in cleaning not to allow contact of cleaning solutions with clothing as much as possible. If circumstances dictate contact will occur (*e.g.*, splashing, high wind), waterproof outer clothing must be worn (*e.g.*, foul weather gear or rain gear).

Decontamination procedures may vary depending on specific Field Sampling Plan specifications, and unique contaminants of concern at specific locations. The project workplan may designate collection of equipment rinse samples to document effectiveness of cleaning.

This SOP does not address radioactive decontamination, PPE for radioactive waste, or disposal of radioactive contaminated waste material.

V. Reference

American Society for Testing and Materials (ASTM), 1994. Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. Designation: D 5088 – 90.

Title: Sediment Probing

I. Introduction

This procedure describes the equipment and methods to be used to conduct sediment probing at the Lower Passaic River Restoration Site. This procedure specifically addresses probing the sediment at each core sampling location to determine the approximate sediment thickness and general sediment type.

II. Equipment and Supplies

The following equipment will be needed to conduct sediment probing:

1. Calibrated Steel Rod to investigate the sediment type, probe the thickness of unconsolidated sediments at each core sampling location, and to determine the length of core tubing to use.
2. Personnel protective equipment (PPE) - including hard hat, steel toe boots, and disposable gloves. (refer to HASP for full PPE requirements).
3. Log sheets to record all field collected data.

III. Guidelines

1. Using the on-board RTK DGPS system, maneuver the sampling vessel to within 10 ft (maximum distance) of the pre-programmed target coordinates for each core sample location, and stabilize the vessel as much as possible.

   Confirm the location by examining the site map, bathymetric survey map, and landmarks.

2. Use a calibrated steel rod to probe the sediment. The probe should be sharpened at one end, and be calibrated at specific interval (*e.g.*, 6 inches).

3. Probing should be conducted 3 to 5 feet away from the sampling location to avoid disturbance of the sediment where the sample will be collected.

4. Push the sharpened end of the probe into the river bed, taking note of the depth of penetration and the type of resistance encountered. Use both hands and hold arms close to the chest to advance the probe vigorously when determining the depth extent of the unconsolidated layer.

5. When initial probe is complete, move the probe laterally and repeat the above probing step three or more times. Maintain the minimum three foot distance from the sampling location.

6. Record the average sediment thickness encountered (to the nearest 6 inches) and estimated sediment type (see guidance below) in the field log and the field application.

   A. Bedrock refusal will have a distinctive "clink" and there will be no penetration.
   B. Gravel or cobbles on top of the bedrock surface will produce multiple clinkings and the probe strikes the larger rock particles.
   C. Sandy material will have a gritty or granular feel and will make a muted, raspy sound as the probe penetrates. There will generally be some resistance to probing, and that will increase with the depth of penetration.
   D. Silty material will be smoother and will probably allow the greatest penetration. The probe will smoothly move through silts and will make little or no sound.
   E. Clay will allow for a smooth penetration, but will be "stickier" than silt and will not allow as much penetration.
   F. Sometimes finer materials will adhere to the probing rod and will allow for verification by pulling the rod out of the water.

7. If the probing results are inconsistent between the three locations, record the estimated sediment type as that which is the most representative of the three probes, and note the inconsistency in the field log and the field application.

IV. Reference

Memo: Sediment Probing Oversight Guidelines; Hudson River PCBs Superfund Site. Dave Scheuing, TAMS. September 2004.

Title: Vibracoring – Collecting High and Low Resolution Cores

I. Introduction

This procedure describes the equipment and methods to be used to collect sediment cores for the Lower Passaic River Restoration Project. This procedure specifically addresses collection of sediment cores via vibracoring, which is expected to be employed during the High Resolution and Low Resolution Coring Programs.

II. Equipment and Supplies

The following equipment will be needed to collect sediment cores:

1. Sampling Boat capable of deploying vibracoring apparatus and with sufficient room for all vibracoring operations (*i.e.*, core tube and equipment storage, lay down area, and working space). Sampling boat must also be properly sized to operate in the typical water depths and conditions anticipated at the project site.

2. Calibrated Steel Rod to investigate the sediment type, probe the depth of unconsolidated sediments at a sampling location, and determine the length of core tubing to use (refer to SOP-8).

3. P3 Vibracorer, or equivalent, and ancillary equipment required for use.

4. Lexan Tubing of appropriate diameter (approximately 4.00 inch O.D.) and wall thickness for use with the vibracoring apparatus.

5. Core Barrel of appropriate diameter (capable of securing a 4 inch O.D. tube) and wall thickness for use with the vibracoring apparatus and Lexan Tubing. Alternately, aluminum coring tubes may be used in lieu of Lexan core tubes and core barrels, if necessitated by sampling conditions.

6. Ponar Dredge to use at locations where core samples cannot be collected (e.g., due to shallow sediment depth or other coring difficulties).

7. Personal protective equipment (PPE) - including hard hat, steel toe boots, tyvek suits, life vests, safety glasses, ear plugs/muffs, and disposable gloves. (refer to HASP Core Document and Addenda for full PPE/chemical-resistant clothing requirements).

8. Power Source for electronic equipment (*e.g.*, laptop computer, printer) equipped with GFCIs.

9. Miscellaneous Supplies – Core caps, 3M Scotch Super 33+ water resistant electrical tape, aluminum pans with lids, coolers, ice, saw for cutting tubing, five gallon buckets with lids, plastic garbage bags (large and small), rope, tarps (and/or insulating blankets) decontamination supplies, measuring tapes, scales, field books, pens, pencils, permanent markers, digital camera, laptop computer, printer, field application, and DGPS.

III. Core Collection Procedure

1. All data from sediment core collection activities will be recorded in the laptop-based field application on the sampling vessel. Upon completion of sampling at one location, all data obtained during core collection will be entered into the field application. Blank field log sheets that can be used to record information manually also will be provided in case of difficulties with data entry or equipment. Any manually recorded data will be transcribed into the field application at the end of each day.

2. If the water in a location is too shallow for the sampling vessel to navigate, the sample will be collected using hand coring techniques (see SOP 13). If the location is reached by wading, the DGPS antenna will be hand carried to determine the coordinates of the actual sampling location.

3. Using the on-board GPS system, maneuver the sampling vessel to within10 ft (maximum distance) of the preprogrammed target coordinates for each sample location and stabilize the vessel as necessary, using anchors or spuds.

   - Confirm the location by examining the site map, bathymetry survey, and landmarks.
   - Record the following in the field application:

     1. Date
     2. Sample ID
     3. Target Location
     4. Water Depth
     5. Tide Stage
     6. Time
     7. Weather Conditions

- The GPS unit should be mounted as close as practicable to the vibracore deployment to identify the core location as accurately as possible.

4. Don personal protective equipment in accordance with the HASP Core Document and Addenda.

5. Use a calibrated steel rod to probe the sediment surface to determine the sediment thickness and type in accordance with the Sediment Probing SOP-8.

   - If the estimated sediment thickness in the probing area is greater than 6 inches, record the probing information in the field application and attempt to collect a core using the vibracorer.
   - If the estimated sediment thickness at the probing are is less than 6 inches, additional probing of the sediment area will be conducted within 3 ft of the target location for deeper sediments. If thicker sediment deposits are found, relocate the boat to the new coordinates and attempt to collect a core. If no deeper sediment deposits are encountered, a sediment grab sample may be collected using a ponar dredge.

6. Record the probing depth and sediment description in the field application.

7. Clean the core barrel with a wash down pump, pressure washer, or steam cleaner as appropriate. Because of the direct contact with sample material, the core nose catcher assembly should be carefully decontaminated in accordance with SOP-6.

8. The Vibracoring Subcontractor will mount a clean, decontaminated clear plastic coring tube liner within the vibratory coring apparatus.

   - The core liner and core catcher, etc. will be assembled and attached to the vibracorer head as per manufacturer's instructions. Note: Core catchers shall be avoided where possible. The field team leader will be consulted on the use of core catchers on a location by location basis.
   - The rigid liner and core tube are to be seated securely in the vibracore "chuck" or head. The check valve must have a tight seal and be free of debris. [Note: in the case of consistent poor recovery, the Vibracoring Subcontractor should be directed to examine the check valve and clean or replace, if necessary.] The driller will not be reimbursed for unsuccessful cores (sediment that drops from the core due to poor check valve operation or other equipment failure.)
   - The vibracore apparatus will be attached to the end of a cable to so that it can be winched/lowered to the river bottom.

9. The Vibracoring Subcontractor will lower the coring apparatus, with the core tube attached, slowly and vertically through the water column, until the river bottom is reached. When the nose reaches the river bottom, the vibracore unit will be turned on. Note the start time. Do not permit the Vibracoring Subcontractor to advance the core tube into the sediment under its own weight before activating the vibracoring apparatus, but the core tube should be lowered slowly and allowed to contact the sediment prior to turning on the unit, to avoid disturbing fine-grained surficial sediments.

10. The Vibracoring Subcontractor will advance the core into the sediment until either the desired depth or refusal is encountered. Refusal is defined as the depth at which no additional penetration can be achieved in a one-minute period. Measure and record the depth of core tube penetration into the sediments in the field application.

11. The Vibracoring Subcontractor will turn off the apparatus and allow the core to settle for approximately 5 minutes.

12. The Vibracore subcontractor will pull the core upward out of the river bottom (using a winch as needed) and raise it to the surface. If the corer refuses to come free, the unit should be vibrated until it is extractable. The apparatus must be maintained in a vertical position during ascent to the surface and all subsequent handling through sediment core processing. Vibrating the core while it is being removed should be avoided as much as possible since sample may be lost from the bottom of the core and the entire core may need to be rejected as a successful core by the field team leader.

13. As the core is being retracted, before the bottom of the core tube breaks the water surface, the Vibracore Subcontractor is to place a cap on the bottom of the tube to prevent the loss of material from the core tube and affix the cap with 3M Scotch Super 33+ water resistant electrical tape.

14. Remove the core tube liner from the coring apparatus following the manufacturer's instructions. The core must be maintained in a vertical position during removal.

15. Estimate the recovered length of the sediment core and note it in the field application.

    - The length of the recovered sediment core will be measured directly within the recovered core tube. If necessary, a decontaminated stainless steel rule with a "foot" to probe for the sediment surface from the top of the tube may be inserted into the top of the core tube to "feel" the surface and locate the top of the core.

- The distance between the top of the sediment in the core tube and the bottom of the coring tube corresponds to the estimated length of the recovered core.

16. Compare the length of the recovered core with the core penetration depth to calculate the percent recovery, and assess the core.

    - The following recovery criteria are to be met for low resolution cores: the recovered length of the sediment core must be more than 75% of the penetration depth and the core has less than 10% void space.
    - The following recovery criteria are to be met for high resolution cores: the recovered length of the sediment core must be more than 85% of the penetration depth and the core must be as free of voids as is possible.
    - If an insufficient amount of material is recovered, or if the core contains voids that are greater than one inch per foot of core length, cap the top and put the core tube aside while additional attempts are made to meet recovery goals (see below). If a compliant core is obtained, discard the non-compliant core into a re-sealable 5-gallon pail and store for subsequent IDW disposal.
    - An additional attempt will be made at a minimum distance of 1ft from previously attempted locations, and should have a penetration at least 6 inches deeper than the previous attempt, if feasible (e.g., refusal or the maximum penetration for the tube length was not reached). A maximum of three attempts to collect a core will be made for a given location ID.
    - Rinse the core tubes with site water between consecutive attempts, collecting all rinsate and discarded sediment for appropriate disposal.
    - If all three attempts to collect a core are unsuccessful based on recovery alone (*i.e.*, less than target % recovery, or unacceptable void space), retain the "best" (least voids/highest percent recovery) core for analysis and put a flag in the field application that indicates that the targeted recovery was not achieved.
    - If no recovery is consistently obtained, collect a ponar dredge sediment grab sample and note conditions preventing core collection in the field database.

17. Seal the top of the core tube with a cap and duct tape, and rinse the outside of the tube with river water.

18. After a successful core recovery, enter prompted information into the field application:

    - Time of recovery
    - Actual coordinates of the sample location
    - Core tube material (*e.g.*, Lexan®)
    - Core penetration depth (inches) (if not recorded earlier)
    - Core percent recovery
    - Observations, including probing results (if not recorded earlier)

19. Draw an arrow on the core tube with permanent marker to mark the top of the core. Using permanent marker, label the core with the sample ID, date, time, and recovery. If available, core labels will be completed and affixed to the core tube with the electrical tape.

20. Store the core vertically, either in a core tube cooler on ice (if available), or in a tall garbage can filled with ice. Lash core tubes securely to the railing of the vessel in a low traffic area. Use a thermal reflective tarp to keep the cores in the dark until they are transported to the field processing facility, if available.

21. If long cores are collected the cores may need to be cut prior to moving the vessel. The core may be cut using a decontaminated saw blade attached to a reciprocating saw. Once the Lexan is cut a decontaminated flat blade will be inserted into the core to prevent the core from slipping out. The core segment will be capped, labeled, and taped secure. For cores collected in aluminum tubes a pipe cutter will be used to cut the core tube.

22. At locations where core samples cannot be collected, grab samples will be collected. Lower a ponar dredge until it comes in contact with the sediment, which should trigger the release mechanism. Retrieve the ponar dredge and empty the contents into a new aluminum pan. Repeat the above steps until sufficient material is obtained (about 3 tries). Seal container with lid and tape. Label the container with permanent marker indicating sample ID, date, and time. Place aluminum pan on ice in a cooler.

23. Decontaminate the ponar dredge, if used, according to the SOP-6.

24. At the end of each day, the processing laboratory coordinator will access the coring information via the project website to prepare for subsequent core processing. Additionally, a hard copy of the field application will be printed out. The hard copy will serve as a back-up to the electronic copy, as well as the chain

of custody form from the field to the processing laboratory. This form will be signed by sample collection personnel and core processing personnel at the time that the core processing personnel take custody of the cores.

IV. References

Passaic River Dredging Pilot Study Quality Assurance Project Plan, Revision 1. June 4, 2004.

Title: Split Spoon Sample Collection

I. Introduction

This procedure describes the equipment and methods to be used to collect split spoon sediment samples for the Lower Passaic River Restoration Project. This procedure specifically addresses the collection of split spoon sediment samples using a rotary drilling rig or a sediment coring vessel equipped to advance casing and split spoons.

II. Equipment and Supplies

The following equipment will be needed to collect split spoon samples:

1. Drilling Barge: capable of securing at least one drill rig (truck, skid, or tripod) with sufficient room for all drilling operations (*e.g.*, mud tub, drilling equipment footprint, laydown area, working space). Sufficient room must also be available for storage of collected sediment samples and undisturbed samples (*e.g.*, Shelby tubes). Barge must also be properly sized to operate in the typical water depths and conditions anticipated at the project site. Some sediment coring vessels are also equipped to advance split spoons and casing.

2. Rotary Drilling Rig (truck-mounted or skid type): with all associated drilling equipment.

3. Tripod Drill and all associated drilling equipment for use in areas where site access is limited (*e.g.*, slopes or edge of shoreline).

4. Shelby Tubes conforming to thin-walled tube specifications outlined in ASTM D 1587 with a 3-inch O.D. Wax and end caps will also be provided for proper field sealing.

5. Casing: The borings will be cased, where appropriate, with pipe or other approved materials to allow for undisturbed soil sampling and rock coring. The casing will have a minimum diameter of 4 inches.

6. Drill Bits: Tri-cone roller bit and/or drag bits that deflect the circulating drilling fluid horizontally will be used to advance the bits through the sediment soils. The bits must be appropriately sized to ensure adequate installation of casing.

7. Bentonite/Portland Cement: Cement Grout mixture as approved by the Engineer.

8. Personnel protective equipment (PPE): including hard hat, steel toes boots, safety glasses, ear plugs, and disposable gloves.

9. Miscellaneous Supplies – Sample jars, five gallon buckets with lids, garbage bags (large and small), decontamination supplies, measuring tapes, scales, field books, pens, pencils, and pavement markers, digital camera, field application equipment, and GPS.

III. Guidelines

1. Using drill rig hammer or equivalent hammering device, set outer casing approximately 5 feet into river floor sediment. Outer casing should be directed through "moon-hole" or equivalent attachment structure on the drilling platform of the barge. This casing will help prevent river water from entering the boring, and prevent drilling mud from spreading across the river floor. Make sure barge is properly anchored or barge feet are properly set in place so that casing does not move from its original position.

2. Position drilling mud-tub to the drilling platform such that the mud-tub's inlet will receive drilling fluid circulation from the casing.

3. For collection of geotechnical samples via a rotary drill rig on a sampling barge, collect split spoon sediment samples via standard penetration test procedure ASTM D 1586 and undisturbed samples via thin-walled tube sampling ASTM D 1587. Conform generally to the above-referenced guidelines when using a variant of this equipment such as may be available on other sediment sampling vessels.

4. After drilling activities are complete, pump drilling fluids out of casing.

5. Grout borehole from the bottom-up with the engineer's-specified mixture of bentonite and Portland cement.

6. Pull casing from borehole.

7. Decontaminate split spoons, casing, etc. in accordance with SOP-6.

8. Containerize and dispose of Investigation Derived Waste (IDW) drilling fluids, and decontamination fluids in conformance with SOP-22.

9. Complete boring logs on the attached HTRW Drilling Log.

10. At the end of each day, the processing laboratory coordinator will access the information recorded for each split spoon sample collected via the project website. Additionally, a hard copy of the field application will be printed out. The hard copy will serve as a back-up to the electronic copy.

IV. References

ASTM D1586-99 Standard Test Methods for Penetration Test and Split-Barrel Sampling of Soils

ASTM D1587-00 Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

Title: Core Processing – High Resolution

I. Introduction

This standard operating procedure (SOP) describes the process for handling, evaluating, segmenting, and sampling high resolution sediment cores for measurement of physical parameters and chemical, radionuclide, and geotechnical analyses. This processing procedure applies to sediment cores collected using several potential collection methods, including vibracoring, hand or gravity coring, and advancing split spoons and casing. High resolution cores are those cores segmented into sub-samples at very fine intervals, some as short as 2 cm in length, to characterize sediment depositional chronology.

II. Equipment and Supplies

The following is a comprehensive list of sampling equipment. Not all equipment and supplies listed below will be needed for all core processing procedures.

1. Sediment Cores
2. Vertical Core Stand and Clamps
3. Plastic Basin and Plastic Sheeting
4. Core Log Sheets
5. Disposable Gloves
6. Reciprocating Saw/Sander and/or Aluminum Tubing Cutter
7. Electric Drill
8. Electric Scissors, Router, and/or Aluminum Shears
9. Tyvek Suits
10. Utility Knife
11. Safety Glasses and/or Face Shield
12. Aluminum Pans and Foil
13. Decontaminated Spoons, Spatulas, open-barrel syringes, and/or "Scoopulas"
14. Scales for Weighing Cores and Segments
15. Scales for Weighing Small Sample Volumes
16. Engineering Tape Measure
17. Sample Jars
18. Sample Labels
19. Wire/Titanium Knife
20. Stainless Steel Mixing Spoons
21. Extrusion Tools

III. Guidelines

Cores should be held overnight to allow the sediment to settle in the core tube prior to sediment processing. Cores will be kept on ice until they are processed. The field sampling team will perform the following activities associated with each core: photo-documentation, visual description, sample processing and homogenization, sample jarring, chain-of-custody and shipping documentation. Sediment samples will be analyzed for radiological dating purposes, and to determine the representative chemical and geotechnical characterization of the sediments in the study area.

1. Core Sampling: Two primary methods are available for removing sediment from cores for sampling and analysis, depending on the data needs. Please refer to Method 1 when sampling for biological and physical properties analysis. Refer to Method 2 when sampling for chemical and radionuclide dating analyses. Sampling for engineering parameters is described later in this SOP.

- Method 1: Once the core liner has been split open (using a router and cutting jig, circular saw or utility knife), use tools made from non-contaminating materials (glass, stainless steel, Teflon) to sample uniform amounts of sediment from the core. Avoid removing sediment that is in contact with the core liner, thereby reducing possible cross-contamination. Place the sediment in a pre-cleaned stainless steel bowl and mix thoroughly until a homogenous mixture is prepared (color and texture).

- Method 2 (For Chemistry Samples): The core is managed vertically at all times and samples are collected continually as the core is segmented from top to bottom. For chemistry samples, it is imperative that the sidewall smear is kept from the sample. Sediment samples will be obtained from each segment using one of the methods described below (see Core Segmentation). NOTE: For very short core segments, where the amount of available sediment sample is limited, all the sediment remaining in the core segment, after the chemistry samples have been removed, may be used for the radionuclide dating analysis. After recording physical parameters, place the sediment removed for chemistry analysis from the segment in a new, disposable food-grade aluminum pan and mix thoroughly until a homogenous mixture is prepared (color and texture). **Method 2 will be the preferential method for all High Resolution Coring Program efforts.** After the jars for chemistry analysis have been filled, the remaining core segment materials for radiological dating analysis may be placed in the same pan for mixing prior to putting in its sample jar. See core segmenting section below for details on segmenting cores, avoiding sidewall smear and handling short core segments with small sample volumes. The methods for obtaining the sediments from the core segments is discussed below (see Core Segmentation).

2. Core Storage: Proper core storage is a vital part of the process. Sediment cores will be kept on ice from the time they are collected on the boat until they are segmented. Sediment cores will be placed in iced core storage holders while aboard the boat and transported to the field facility in these holders. The core sections that stick out of the top of the holder shall be wrapped with a heat reflective blanket. Sediment cores must be kept at the appropriate temperature (frozen for cores and samples to be archived, otherwise 4°C) and in the appropriate orientation (vertical) until they are cut open and segmented for sub-sample analysis. It may be necessary to initially cut cores into two or more segments so that they will fit into a vehicle for transportation to the core processing facility. Archive cores will be cut into maximum 5' lengths, since the freezer has a headroom clearance of 6 feet. This can be accomplished using a reciprocating saw (Lexan cores) or tubing cutter (Aluminum cores) with a decontaminated blade. All exposed ends of the cores will be recapped following cutting, and the core segments will be labeled with the core designation, location, depth intervals, and an arrow to denote the proper orientation.

3. Initial Physical Measurements: After the core has been allowed to settle overnight, remove the upper cap and make a small mark on the core at the sediment water interface. Measure the length of the sediment in this core tube and add it to the length of the remaining core sections. (Inspect all core sections for voids since this will also impact recovery and may make cause the core to be rejected.) This is the length of recovered material in the core tube. Compare this length against the initial cored depth and compute the percent recovery. The required percent recovery for high resolution cores is 85%. If the percent recovery is less than 85%, then, the potential need to discard the core is to be discussed with the Processing Facility Manager. With a small diameter drill bit, drill through the core liner at a point just above the sediment/water interface and drain the excess water from the core into a container for disposal. Weigh the entire core on an engineering scale and record the total weight, in grams.

4. Bulk Density Calculation: The sediment bulk density for each core will be estimated by weighing each core after removing the overlying water. The calculation for bulk density uses the following formula:

$$\rho_{bulk} = \frac{W_{sediment}}{A_{tube} * L_{sediment}} = \frac{W_{sediment\&tube} - W_{tube}}{A_{tube} * L_{sediment}}$$

where:

ρ_{bulk}	=	wet bulk density in g/cm^3
$W_{sediment}$	=	weight of sediment in the tube
$W_{sediment\&tube}$	=	weight of sediment and the tube
W_{tube}	=	weight of the empty coring tube
	=	length of tube * weight of tube per unit length
A_{tube}	=	inner cross sectional area of the coring tube
$L_{sediment}$	=	length or thickness of sediment in the tube (Note that this is probably not the length of the coring tube itself)

5. Setup: (Method 1) Prior to splitting the cores, secure the cutting jig to a table using "C"-clamps. (Method 2) Cores that must be processed vertically will be held in specially-constructed core processing stands.

6. Core Segmentation can vary depending on the analysis type. The first method is for cores to be analyzed for biological and physical parameters. The second method is for cores that have chemical and/or radionuclide analysis requirements.

   - Method 1: Cut open the capped end of the core using a utility knife. Cut the Lexan tube containing the core longitudinally with electric scissors, aluminum shears, or a router. Rotate the core 180° and repeat cutting procedure so it can be split into two equal parts. Avoid contaminating the sample whenever possible. Split the core into two halves using a wire tool or titanium knife and open the core so that sediment from both halves is visible. The core is now ready to be sampled. Please refer to SOP-12: Core Processing - Low Resolution Cores, for sediment characterization techniques.

   - Method 2 (For Chemistry Samples):_Cores that are analyzed for chemical contaminants and radionuclide dating are to be handled and processed vertically at all times, rather than horizontally. Cores will be segmented into 44 intervals, irrespective of the length of the core. An additional step will be performed solely for the surficial sediment layer (0 to 2 cm) to permit the measurement of Be-7, described later. Segmenting will be done as follows:

A. Locate the black to brown sediment color transitions;
B. Measure and segment the black sediment portion into 36 equal length segments;
C. Further divide the top four segments equally into eight segments for a total of 40 black segments (32 long and 8 short segments);
D. Divide the uppermost portion of the brown sediment into 4 segments, with each segment twice the thickness of long segments used in the black sediments.

As an example, for a core of approximately 190 cm in length with the black-brown sediment transition at 144 cm, this procedure would yield the following:

- 8 segments, 2 cm thick each, representing black sediments from 0 to 16 cm below the sediment-water interface.
- 32 segments, 4 cm thick each, representing black sediments from 16 to 144 cm below the sediment-water interface, ending at the black-brown sediment horizon.
- 4 segments, 8 cm thick each, representing brown sediments from 144 to 176 cm below the sediment-water interface.

Material below 176 cm may be archived or discarded, depending on the judgment of the field crew.

Due to sample volume requirements, however, a 2 centimeter minimum core segment length has been established for this project. Therefore, for very short core retrievals, such as for a 60 centimeter core, a 2 centimeter core segmentation limit will produce a total of only 30 segments.

Segmentation and sampling go hand-in-hand with this process. Segmentation will be conducted using a tubing cutter for aluminum core tubes or an oscillating saw for Lexan core tubes. As each segment is cut from the top of the core tube, a large, decontaminated, flat-bladed knife or stainless steel plate will be inserted below the segment and used to lift the segment into a disposable, aluminum food-grade pan for extrusion, classification, and sample processing. Slicing away the outer edge of the core is important during extrusion to assure core streaking/smearing is not a factor contributing to cross-contamination of the samples. Report any observed voids to the

Processing Facility Manager; the presence of voids in the sediment may require the core to be discarded.

Due to the variety of segment lengths encountered, the following methods will be used to obtain representative, uncompromised samples:

For short segments: To prevent disturbance of the core sample which may occur due to the vibration caused by an oscillating saw used to cut very short core segments (as small as 2 centimeters in length), an extrusion tool (which pushes the core segment up and into a new section of Lexan tubing cut to the length of the desired segment) is used to remove the sediment from the core. To avoid collecting sediments impacted by side-wall smearing, sediments may be removal using a decontaminated stainless steel scoop, or an approximate 1-inch diameter, open-ended polycarbonate tube section, or open-ended syringe barrel, to "cookie cut" the chemistry samples from the core segment. If very little material is available, it will be used for radionuclide dating.

NOTE (for very short cores): For locations where very little sample volume is available (very short cores), two co-located cores may be collected by the field crew and identified to the core processing staff. To process these cores the following procedure will be followed:

A. Each core will be identified using a separate core number (core segments from these two cores are never to be composited)

B. Both cores will have full radiological analysis (as described in Sub-Section 7 below; however chemistry analysis will be split between the cores (meaning that, for example, one core may be used for the frozen PCB and dioxin/furans analysis, while the other core may be used for the other chemistry analysis requiring immediate analysis). This information will be recorded in the field application for all samples being sent to the laboratory.

C. For samples where only Be-7 samples will be collected from the top 0-2 centimeter layer: The sample will be extruded up and out of the core tube until 2 centimeters of the sediment core is visible: the sample will then be removed using a flat bladed knife and placed in the sample jar. If the sediment is very sloppy, the sample may either be extruded up a little at a time, while using a flat bladed knife to remove the sample until 2 centimeters has bee obtained. Or, alternatively, a decontaminated stainless steel teaspoon may be used to carefully remove the sediment sample down to 2 centimeters.

D. For longer core segments (up to one foot, where sufficient sediment is available for all analysis): Sediments may be removed from the segment (while avoiding sediments impacted by side-wall smear) by driving/pushing a smaller diameter new or decontaminated copper or polycarbonate tube through the core segment. This entire removed section, from the inside of the smaller diameter tube, may be used for all analysis. Alternatively, if the core segment maintains its shape, the core segment may be "shaken" and pushed out of its tube and the outside smear may be sliced away from the sample.

E. Special Segmenting for Berylium-7 Measurement: For longer cores where the length of recovery yields upper core segments greater than 3 cm, the following procedure will be added to the core sampling in order to obtain a Be-7 measurement on the upper 2 cm of sediment.

   i. After extruding the first layer into a sampling holder while still maintaining the layer vertically, remove the portions for all chemical analysis from the entire layer using an open bore glass syringe or similar device.
   ii. After all chemical samples aliquots are removed, the layer is to be split horizontally into two sub layers, each of which will be sent for radionuclide analysis. The upper layer will consist of sediments between 0 and 2 cm, and is intended for Be-7 analysis. The second layer, representing 2 to 'x' cm, where 'x' is the bottom of the core segment will be sent for radionuclide analysis. In this manner, Be-7 analysis will be limited to the top 3 cm of sediment in all cores, with 2 cm being the most common layer thickness.

7. <u>Holding times</u> vary depending on the analysis of the samples and impact sample shipment. Please refer to Tables 3-1 through 3-6 in the QAPP for specific holding time and storage parameters.

   For this project, to optimize project funding, the following sample shipment/storage schedule will be adhered to, due to analytical method holding time restrictions and the analytical result sequencing needs:

   Immediately:

   A. Freeze archive cores (archive cores are the additional cores collected adjacent to the core being used for analysis)

B. The top 2 centimeters of each core will be sent for Be-7 analysis

C. The top 33 segments, of the total 44 segments, will be sent for the remaining radionuclide analysis

D. Each of the 44 segments will be frozen for later PCB and Dioxin/furans analysis

E. Each two successive segments, totaling 22 samples from each core, will be sent for all remaining chemistry analysis, and grain size

Once analytical results have been assessed:

A. If required, send the remaining 11 segments for radionuclide analysis (excluding Be-7)

B. Send up to 22 segments for PCB and Dioxin/furans analysis, combined in paired or multiple sediment segments as directed (this will consist of placing the jars in Ziploc bags, for the lab to combine-since they will be frozen)

8. Decontamination: Decontaminate all used tools, bowls, and mixing implements in accordance with SOP 6: Decontamination of Soil Sampling Equipment.

9. Sample Containers: The SOP "Sample Containers, Preservation, and Handling" and Tables 3-1 through 3-6 in the QAPP provide detailed information.

10. Quality Control: To ensure quality control in this process, appropriate decontamination procedures must be followed and caution must be taken to ensure that the samples are not cross-contaminated. With varying requirements for all analysis discussed in this SOP, it is critical to ensure that pertinent requirements are met for each core processing effort. Decontamination solvents may be submitted for residue analysis to ensure cleanliness, if directed by the SQO. Refer to the QAPP for the required number of field duplicates, MS/MSD, etc., for each analytical parameter.

IV. References

United States Environmental Protection Agency. Office of Water. 1995. "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations." Report Number EPA 823-B-95-001.

McNeil, J; Taylor, C; Lick, W. "Measurements of Erosion of Undisturbed Bottom Sediments with Depth." J. Hydr. Engrg., Vol. 122, Issue 6, pp. 316-324 (June 1996).

Title: Core Processing – Low Resolution

I. Introduction

This standard operating procedure (SOP) describes the process for handling, characterizing, segmenting, and sampling low resolution sediment cores for chemical, radionuclide, and geotechnical analyses. Proper handling of the cores (*e.g.*, keeping cores in a vertical orientation during collection, transport and storage) is critical to obtain adequate quality sediment data. This processing procedure applies to sediment cores collected using Vibracore, piston, gravity, hand-push or other similar coring methods. Low resolution cores are those cores segmented into subsamples generally at 6-inch to 2-foot intervals to characterize the spatial extent of contamination and sediment physical properties. For this project, low resolution core segments lengths will be established based on the depth of the silt material: resulting in segment lengths of from approximately 1.5 feet to 5 feet, or more. Processing low resolution cores is described below.

II. Definitions

Definitions are referenced from the ASTM D2488-00: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Please refer to ASTM D2488-00 for more detailed definitions.

1. Clay: fine-grained soil with putty-like properties (plasticity) when containing water. If the soil is dry then it becomes hard, strong, and solid. Has a plasticity index equal to or greater than 4.
2. Gravel: particles of rock that are larger than 4.75mm yet smaller than 75 mm
   - Coarse: greater than 19mm smaller than 75mm
   - Fine: less than 19mm larger than 4.75 mm
3. Organic Clay: clay with organic content high enough to influence soil properties
4. Organic Silt: silt with organic content high enough to influence soil properties
5. Peat: dark brown to black decomposing vegetative matter with organic odor and spongy consistency
6. Sand: particles of rock between 75 μm-4.75mm:

- Coarse: 2 mm-4.75 mm.
- Medium: 425 µm-2 mm.
- Fine: 75 µm-425 µm.

7. Silt: a fine-grained soil (<75 µm) with little or no plasticity. When soil is dry has little or no strength.

III. Equipment and Supplies for Core Processing

1. Vertical Core Stand with Clamps
2. Plastic Basin and Plastic Sheeting
3. Geotechnical Gauge- typically contains size classification, with actual sand grains from coarse to silt, roundness chart, percent composition chart, unified soil classification system (USCS), common soil colors, soil and sand compacting classifications.
4. Environmental Sample Core Log - to record core characterization (Appendix 1)
5. Key to Core Data Logs - guide to core descriptions and symbology (Appendix 2)
6. Decontamination Solutions: Laboratory soap, 1% nitric acid, isopropyl alcohol, hexane, and distilled/deionized water to clean utensils and other non-dedicated equipment
7. Decontaminated/Dedicated Stainless Steel: Pans, Bowls, , Spoons, Spatulas and/or Scoopulas
8. New Disposable Aluminum Pans
9. Engineering Tape Measure
10. Electronic Scales -for weighing cores and segments
11. Sediment Cores- in Lexan core tubes with end caps
12. Disposable Gloves
13. Tyvek Suits
14. Utility Knife
15. Safety Glasses and/or Face Shield
16. Sample Jars
17. Reciprocating Saw and/or Aluminum Tubing Cutter

IV. Guidelines

1. Core Storage: Proper core storage is a vital part of the program. Sediment cores must be kept at the appropriate temperature (frozen for cores and samples to be archived, otherwise refrigerated/iced at 4°C) and maintained in the appropriate orientation (vertical) until they are cut open and segmented for subsample analysis. It may be necessary to initially cut cores into two or more segments so that they will fit into the vehicle for transportation to the core processing facility. This can be accomplished using a reciprocating saw/sander equipped with a decontaminated saw blade (Lexan cores) or decontaminated tubing cutter (Aluminum cores). All exposed ends of the cores will be recapped following cutting, and the core segments will be labeled with the core designation, location, depth intervals, and an arrow to denote the proper orientation.

2. Holding times vary depending on the analysis of the samples. Refer to Tables 3-1 through 3-6 in the QAPP for specific holding time, storage, containers, and preservation parameters. Below are commonly used, standard holding times.
   - Cores for chemical analysis have a probable holding time of 1-2 weeks, depending on the selected analytical parameters, although samples for metals speciation may have very short holding times. These cores must be processed and submitted to the laboratory prior to the holding time being exceeded. Samples for PCB congener analysis and dioxin/furans analysis may be frozen.
   - Cores for biological testing have a holding time of 6 weeks. These cores must be processed, splits taken, and tests started prior to exceeding the holding times.
   - Cores for physical parameters such as Grain Size and certain engineering parameters should not be frozen. They should remain at 4°C to prevent composition changes in the sediment.
   - Cores slated for Pb-210 and Cs-137 analyses have a holding time of 1 year. Holding times for Be-7 will be a maximum of 1 month. Sediment cores will not be held any longer than necessary prior to radionuclide analysis.

3. Setup: Cores must initially be handled and processed vertically, using specially-constructed core processing stands. Tools and mixing implements must be cleaned and decontaminated as described in SOP 6 Decontamination of Soil Sampling Equipment. The procedures for collecting the initial physical measurements are described in Step 4, below. Core logging (See Step 7, below) should be performed prior to cutting the Lexan core tubes for processing.

4. Initial Physical Measurements: Remove the upper cap and, using a decontaminated probe if the sediment/water interface cannot clearly be observed, confirm the length of the sediment recovered in the core tube and check against the required percent recovery for low resolution cores of 80%. If possible, it is preferred that core measurements be taken from the outside of the Lexan core tube. If the percent recovery is less than 80%, the potential need to discard the core is to be discussed with the Processing Facility Manager. Drill through the core liner at a point just above the sediment/water interface and drain the excess water from the core, or carefully siphon the excess water using a section of dedicated Tygon, or similar, tubing. Weigh the entire core, including the two end caps, on an engineering scale and record the weight.

5. Bulk Density Calculation. The sediment bulk density for each core will be estimated by weighing each core after removing the overlying water. The calculation for bulk density uses the following formula:

$$\rho_{bulk} = \frac{W_{sediment}}{A_{tube} * L_{sediment}} = \frac{W_{sediment\&tube} - W_{tube}}{A_{tube} * L_{sediment}}$$

where:

ρ_{bulk}	=	wet bulk density in g/cm^3
$W_{sediment}$	=	weight of sediment in the tube
$W_{sediment\&tube}$	=	weight of sediment and the tube
W_{tube}	=	weight of the empty coring tube
	=	length of tube * weight of tube per unit length
A_{tube}	=	inner cross sectional area of the coring tube
$L_{sediment}$	=	length or thickness of sediment in the tube (Note that this is probably not the length of the coring tube itself)

6. Core Segmentation: cores will be segmented as follows:

A.. 1)Determine the total core length using all the sections comprising the core, 2) estimate the depth of the silt layer, and 3) determine the slice thickness (6 segments per core; 5 of these equal length segments will be obtained from the silt layer that is located above the depositional or red/brown interface, as appropriate). Note that "final slice thickness" will depend on location of major geological units.

B. Segmentation and sampling go hand and hand with this process. Segmentation will be conducted using a tubing cutter for aluminum core tubes or a reciprocating saw for Lexan core tubes. As each segment is cut from the top of the core tube, a large, decontaminated, flat-bladed knife or stainless steel plate will be inserted below the segment and used to lift the segment into a decontaminated stainless steel bowl, or disposable aluminum pan, for sample removal, classification, and sample processing. Since these are longer segments with varying sample consistency, a variety of methods are proposed for sample removal. No matter which method is used it is important to avoid the outer smeared portion of the sample, adjacent to the core barrel wall. Slicing away the outer edge of the core is important during extrusion to assure core streaking/smearing is not a factor contributing to cross-contamination of the samples.

C. The sample will be processed horizontally. Two cuts will be made along the length of the Lexan or aluminum tube. Decontaminated flat-bladed knifes or stainless steel plates will be inserted along the length of the cut so that the core may be opened with sediment remaining in both halves (DO NOT SLIDE THESE TOOLS ALONG THE LENGTH OF THE CORE SEGMENT). At the center of one of the core halves, scrape away about 0.25 inches of sediment using a decontaminated stainless spoon. Obtain a Encore sample for volatile organics immediately from this location. Avoid contacting the sediments near the side wall of the core (smear area). Then, from the entire length of one half of the core, decontaminated tools will be used to remove sample from the core while avoiding the side-wall smear. The removed sample will be placed in a decontaminated stainless steel bowl, homogenized and placed in the required sample containers. Sample will be shipped to the laboratory or frozen as detailed in the FSP.

7. Core Logging: To describe cores an Environmental Sample Core Log (Appendix 1), a Geotechnical Gauge, and the Key to Core Data Logs (Appendix 2) are required. Core logging should be performed prior to segmenting the core.

   Measure the total length of the core and record it on the Environmental Sample Core Log. Describe the core(s) in the diagram provided on the Environmental Sample Core Log. For each horizon note the color, size (segment length), texture, lithology, and odor. Also note other distinguishing characteristics such as shell hash, detritus, or presence of an organic sheen. Use Appendix 2 as a reference for additional data collection requirements. Note not all categories apply to all samples. These are a guide to the information that can be provided by a core description. Specific descriptions of each category are listed further along in this document. If a photographic record is to be obtained, the core ID should be present in every frame as well as an RGB color indicator and a measuring tape for size reference.

A. Group Symbols: Sediments can be identified by assigning a group symbol. Flow charts representing these group symbols can be seen in Appendix 4 (fine-grained soils) and Appendix 5 (coarse-grained soils).

B. Lithology: The description or physical characterization of the sediment such as the approximate percent of clay, silt, or sand.

C. Dilatancy: the structural change of the soil from stress and pressure over time. This can be tested by shaking and squeezing a small round ball of the sample. The ASTM criteria are listed below and details on how to test the sample are listed in the ASTM D2488 report.

- None: No visible change in the specimen.
- Slow: Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
- Rapid: Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

D. Type: a more descriptive means of describing the soil characters such as sediment size and composition.

E. Color: a very important aspect of the core description and soil identification. Any changes in color should be noted on the sample log along with the location of the color boundary. Use a Munsell Soil Color Chart (can be on Geotechnical Gauge) to acquire uniform descriptions.

F. Consistency: using the symbols on the Key describe the consistency as hard, firm, soft or very soft. Note this is not applicable to soils with large amounts of gravel. The ASTM criteria are as follows:

- Very soft: Thumb will penetrate soil more than 1 in.
- Soft: Thumb will penetrate soil about 1 in.
- Firm: Thumb will indent soil about ¼ in.
- Hard: Thumb will not indent soil but readily indented with thumbnail.
- Very Hard: Thumbnail will not indent soil.

G. Cementation: used on intact coarse-grained sediments. The three options are weak, moderate and strong. The ASTM criteria are as follows:

- Weak: crumbles or breaks with handling or little finger pressure.
- Moderate: Crumbles or breaks with considerable finger pressure.
- Strong: will not crumble or break with finger pressure.

H. Structure: physical layout of the core. Below are descriptions of the ASTM criteria noted on the "Key to Core Data Logs" (Appendix 2).

- Homogeneous: Same color and appearance throughout.
- Stratified: Alternating layers of varying material or color with layers at least 6 mm thick; note thickness.
- Laminated: Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness.

I. Maximum particle size: note the largest particle size seen in the sample. The "Key to Core Data Logs" has the appropriate abbreviations and descriptions. More details can be found in the ASTM D 2488 paper.

J. Odor: Note any organic or non-organic odors that may be released when opening the core. Many soils have a strong, distinctive odor of decaying vegetation. It is important to also note any chemical or petroleum odors.

K. Samples: Used to identify sample ID. Also, this column can be used to denote where the core may have been split to acquire numerous samples.

L. Toughness: the amount of pressure need to roll a sample of the soil into a 1/8th inch diameter (plastic limit) thread and the strength of the thread. The ASTM criteria are listed below.

- Low: Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
- Medium: Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
- High: Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

M. Plasticity: using the information gathered in the toughness test use the ASTM criteria to rate the plasticity of the sample.

- Non-plastic: A 1/8 in. thread cannot be rolled at any water content.
- Low: The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
- Medium: The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.

Sample Containers: Tables 3-1 through 3-6 in the QAPP provide detailed information on sample containers, preservation, and handling. Below are some standard requirements for sediment samples.

- Samples to be analyzed for physical parameters such as grain size and TOC should be stored in pre-cleaned glass jars.
- Samples to be analyzed for chemical parameters should be placed in laboratory certified pre-cleaned glass jars.

8. **Decontamination:** Decontaminate all tools, bowls, and mixing implements in accordance with the following procedures prior to mobilization into the field.

   - Rinse each item with tap water to remove mud or dirt.
   - Scrub the item with a brush and soapy (*i.e.*, Alconox) water.
   - Rinse the item with tap water again to remove any residual soap.
   - Rinse the item with deionized water.
   - Rinse the item with 1% nitric acid.
   - Rinse the item with deionized water.
   - Rinse the item with isopropyl alcohol.
   - Rinse the item with deionized water.
   - Rinse the item with hexane.
   - Rinse the item with analyte-free water.
   - Wrap the item in aluminum foil to protect it until it is to be used, or in the event the item is too large, cover with clean plastic sheeting prior to usage.

An adequate supply of sample handling equipment (*e.g.*, bowls, trowels) will be brought into the field during each field sampling event to avoid the need for field decontamination using solvents, as referenced above. Larger sampling equipment (*e.g.*, corers, grab samplers, vibracore), will be field decontaminated by scrubbing off all sediment visible residue and then rinsing the equipment in ambient water.

9. **Quality Control**. Decontamination solvents may be submitted for residue analysis to ensure cleanliness, if directed by the SQO. Refer to the QAPP for the required number of field duplicates, MS/MSD, etc. for each analytical parameter.

V. Reference

ASTM International Designation: D 2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Edition 2000

VI. Appendices

1. Blank Environmental Sample Core Log Form
2. Key to Core Data Logs
3. Example of Completed Environmental Sample Core Log Form
4. Group Symbol Flow Chart for Fine-Grained Soils
5. Group Symbol Flow Chart for Course-Grained Soils

Appendix 1
Environmental Sample Core Log Form

Core Descriptor (Station): Core Sample ID:

Logged by: Date: Page of

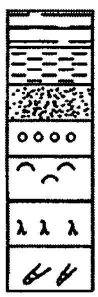
Depth below water surface (ft)	Depth below mudline (ft)	Lithology	Dilatancy	Type	Color	Consistency	Cementation	Structure	HCl reaction	Maximum particle size	Odor	Samples	Comments

Reviewed by________________________ Date____________

Appendix 2
Key to Core Data Logs

KEY TO CORE DATA LOGS

LITHOLOGY



Clay
Silt
Sand
Pebbles
Shells
Roots/organic matter
Worms/worm tubes

TYPE

GW	Well-graded gravels, gravel-sand mixtures
GP	Poorly-graded gravels, gravel-sand mixtures
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures
SW	Well-graded sands, gravelly sands
SP	Poorly graded sands, gravelly sands
SM	Silty sands, sand-silt mixtures
SC	Clayey sands, sand-clay mixtures
ML	Silts and very fine sands, silty or clayey fine sands, or clayey silts, with slight plasticity
CL	Clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
MH	Silts or fine sandy silts with moderate plasticity
CH	Clays of high plasticity, fat clays

COLOR

Selected from Munsell Soil Color Chart

CLAY/SILT CHARACTERISTICS

DILATANCY
N = None
S = Slow
R = Rapid

TOUGHNESS
L = Low
M = Medium
H = High

CONSISTENCY
Penetration of thumb:
<0.25 cm = hard (H)
0.25 – 2.0 cm = firm (F)
2.0 – 4.0 cm = soft (S)
>4.0 cm = very soft (VS)

CEMENTATION
N = Not cemented
W = Weakly cemented
M = Moderately cemented
S = Strongly cemented

STRUCTURE
H = Homogeneous
S = Stratified
L = Laminated
M = Mottled

HCl REACTION
N= None
W = Weak
S = Strong

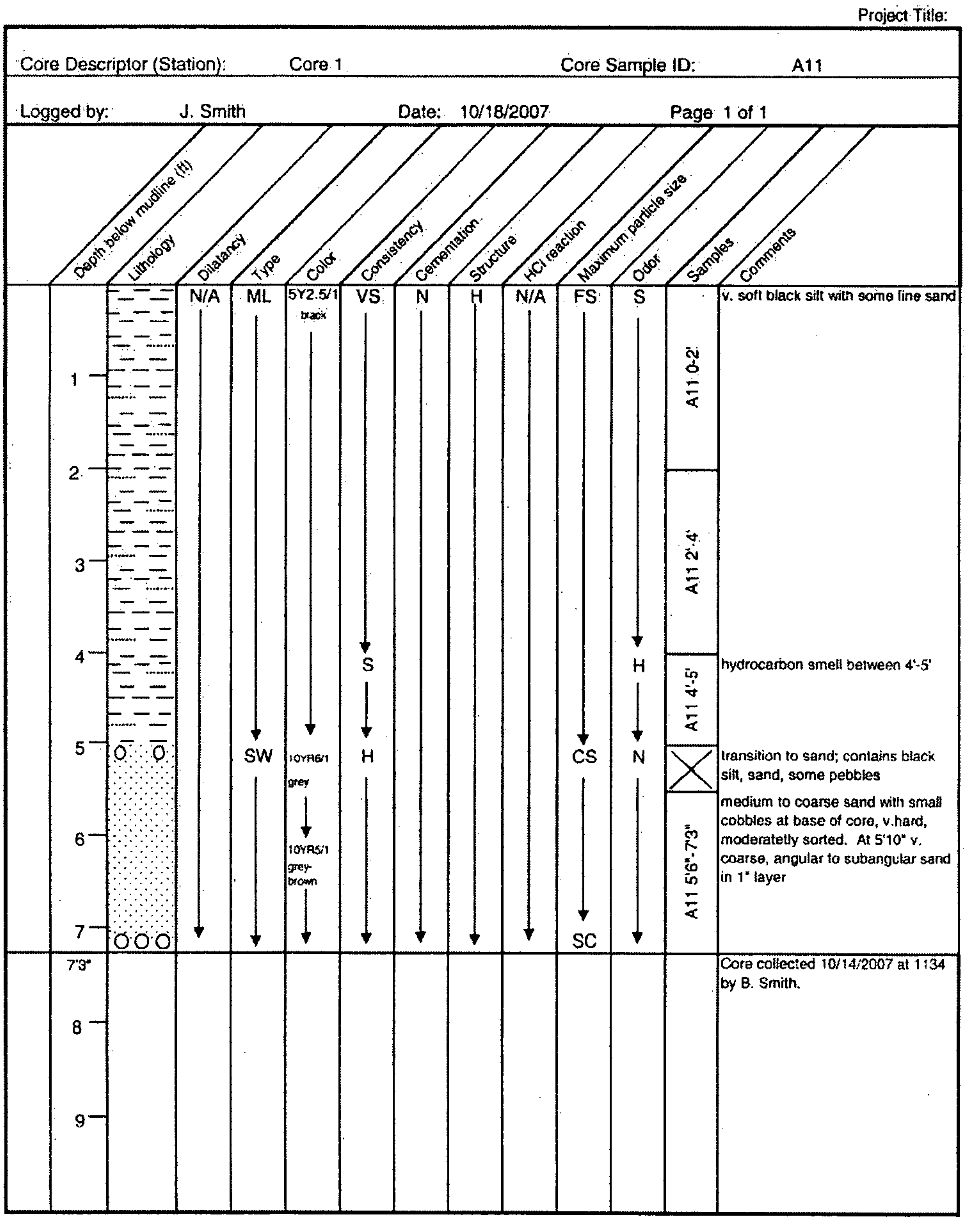
MAXIMUM PARTICLE SIZE
SC = Small Cobble
CP = Coarse Pebble
MP = Medium Pebble
SP = Small Pebble
CS = Coarse Sand
MS = Medium Sand
FS = Fine Sand
VFS = Very Fine Sand
Z = Silt

SA = Sub-angular
VA = Very angular

ODOR
N = None
S = Sulfide; HS = Hydrogen sulfide
P = Petroleum

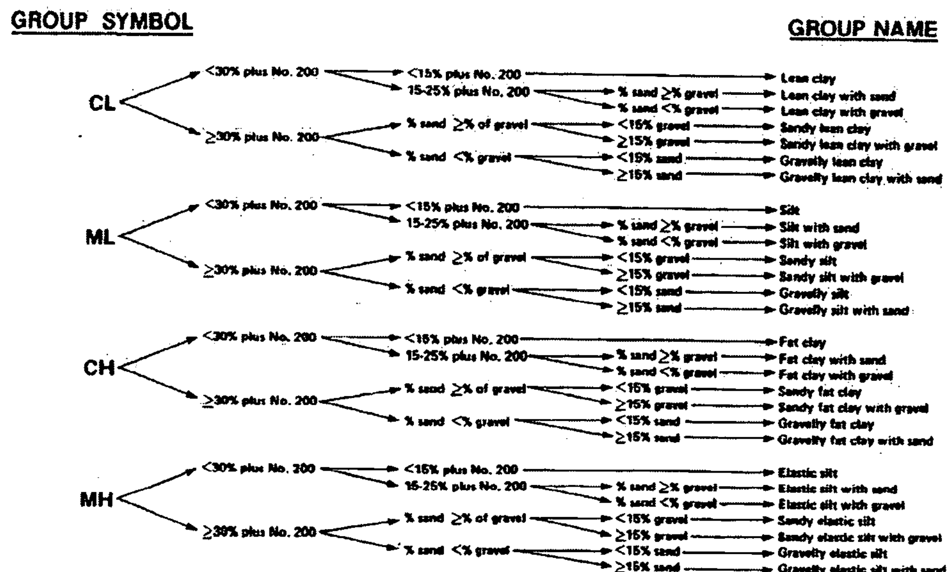
PLASTICITY
N = None
L = Low
M = Medium
H = High

Appendix 3
Completed Environmental Sample Core Log Form



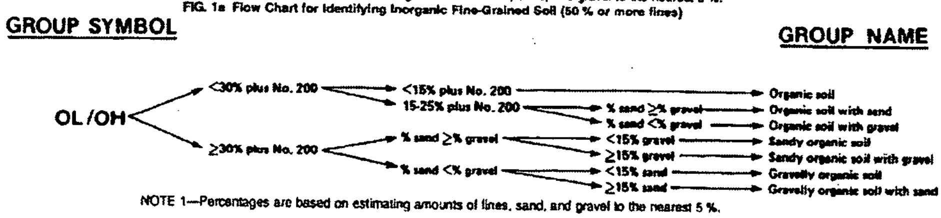
Appendix 4
Group Symbols
Flow Chart for Fine-Grained Soils

D 2488



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

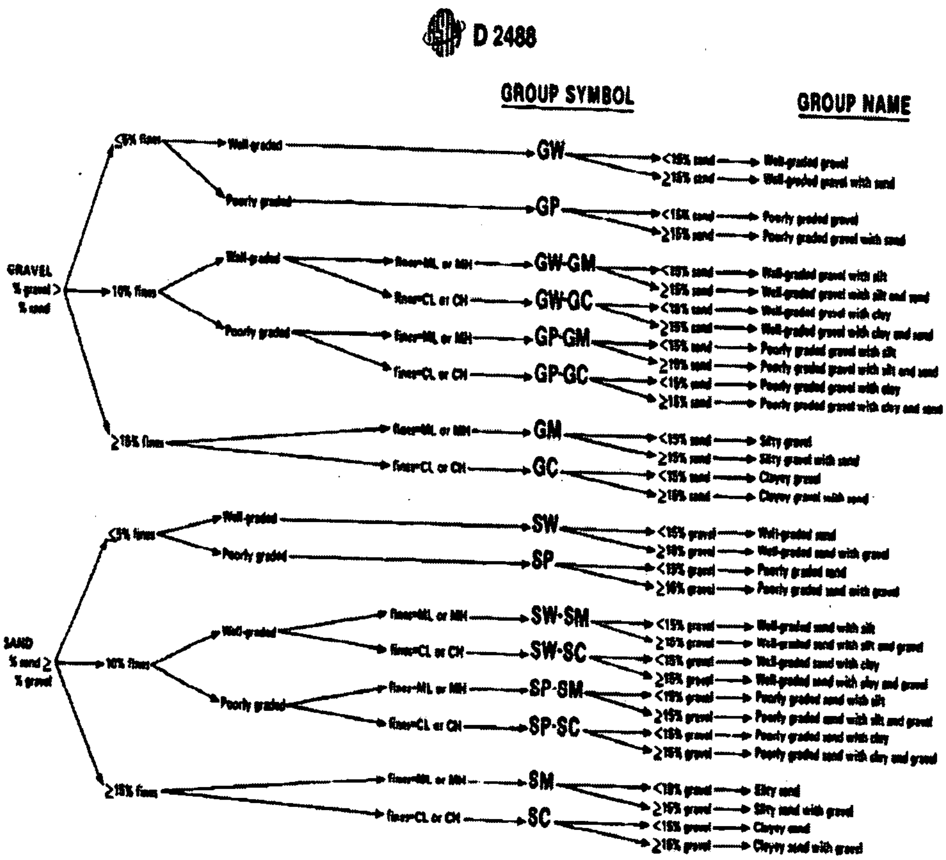
FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

Appendix 5
Group Symbols
Flow Chart for Course-Grained Soils



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

Title: Sediment Collection Using Hand Coring Devices (including push cores, piston cores, etc.)

I. Introduction

This procedure describes the equipment and methods to be used to collect sediment cores for the Lower Passaic River Restoration Project. This procedure specifically addresses collection of sediment cores via hand operated coring devices (*e.g.*, push coring and piston coring). Other coring methods (collection of sediment cores via vibracoring or split spoon and rotary drilling rig) are addressed in SOP-9: Vibracoring – Collecting High and Low Resolution Cores, and SOP-10: Split Spoon Sample Collection.

II. Equipment and Supplies

The following equipment will be needed to collect sediment cores:

1. Push core and ancillary equipment required for use.
2. Piston core and ancillary equipment required for use.
3. Polycarbonate or Cellulose Acetate Butyrate (CAB) Tube of appropriate diameter and wall thickness for use as a liner with the coring apparatus.
4. Hand operated winch (*e.g.*, 'come-along') and tripod or tetra pod (*e.g.*, folding ladder) or other lifting frame if needed.
5. Bentonite-cement grout as required by the workplan.
6. Personnel protective equipment (PPE) - including hard hat, steel toes boots, safety glasses, ear plugs, and clean disposable gloves (nitrile preferred).
7. Measuring tapes, scales, field books, pens, pencils, and pavement markers, digital camera, field application equipment, and GPS.
8. Tape – electrical, duct, and clear packing tape.

III. Guidelines

1. All data from sediment core collection will be recorded in the laptop-based field application. Upon completion of sampling at one location, all data from the core collection will be entered into the field application. The field application will prompt the user for the required information and also automatically upload daily weather and tidal conditions from the NOAA website. Blank field log sheets to record information manually will be provided in case difficulties with data entry into the field computer are encountered. Manually recorded data will be transcribed into the field application at the end of each day.

2. Hand or piston cores are used when the water level is too shallow for the vibracoring vessel to navigate (*i.e.*, less than approximately 2 feet of water), or if a land site location is not accessible by large equipment (*e.g.*, truck or tractor rig). In shallow water, cores will be collected from jon boats, zodiacs, or other appropriate vessel. If on land (*e.g.*, intertidal or other location inaccessible by heavy equipment) appropriate PPE will be used for the hand collected sample. A hand held GPS/antenna will be used to determine the coordinates of the actual sampling location.

3. Using the hand held GPS system, mark a location within 5 feet of the preprogrammed target coordinates for each sample location. Record in the field application the actual location from which the core was collected and the target location.

4. Use a calibrated steel rod to probe the sediment surface 3 to 5 ft away from the target location to determine the sediment thickness and type in accordance with the SOP-8: Sediment Probing.

   - If the estimated sediment thickness at the probing area is greater than 6 inches, record probing information in the field application and attempt to collect a core using the hand core device (steps 5-9).
   - If the estimated sediment thickness at the probing area is less than 6 inches, additional probing of the sediment surface will be conducted within 3 feet of the target location for deeper sediments. If thicker sediments are found, relocate to the new location and attempt to collect a core (steps 5-9).
   - If sediment depth appears to be systematically less than 6 inches, make one attempt at collection with the hand core device. If 80% recovery is not achieved after one attempt, collect a sample with a ponar dredge (refer to SOP-9: Vibracoring (which includes the use of a Ponar Dredge).

5. Once the targeted area is deemed suitable for core collection, mount a clean coring tube onto the coring device.

6. Prior to pushing in the core tube, mark the target penetration depth on the outside of the tube. Lower the coring apparatus with the core tube attached vertically through the water column (cutting edge first) until the sediment water interface is reached. Continue to push or hammer by hand the hand or piston core device until the target depth is reached. If using a piston core, activate the release mechanism.

7. Measure and record the depth of core tube penetration into the sediments in the field database.

8. Pull the apparatus upward out of the sediment/soils (using a hand operated winch from a tripod or other lifting frame as needed), and raise it just above the sediment water interface maintaining the core in a vertical position.

9. As soon as possible (while the core is still under water if possible) place a cap over the bottom of the core to prevent the loss of material from the core tube. Secure the cap in place with electrical or duct tape when brought on board the vessel.

10. Record the penetration depth in the field application. Remove the core liner from the outer tube. Place a second cap on the top of the core tube. Secure the cap in place with electrical or duct tape. Rinse the outside of the core tube with a small amount of river water. Measure the recovered length of the sediment core and record the data in the field application.

11. Compare the length of the recovered core with the core penetration depth.

    - If the recovered length of the sediment core is more than 80% of the penetration depth, keep the core.

    - If an insufficient amount of material is recovered, put the core tube aside while additional attempts are made to meet recovery goals (see below). If a compliant core is obtained, discard the non-compliant core into a re-sealable 5-gallon pail and store for subsequent IDW disposal.

    A. An additional attempt will be made at a minimum distance of 1 foot from previously attempted locations.
    B. A maximum of three attempts to collect a core will be made for a given location ID.
    C. Rinse the core tubes with river water, or tap water and deionized water if river water is not available, between consecutive attempts.
    D. If all three attempts to collect a core are unsuccessful based on recovery alone (*i.e.*, less than 80% recovery), retain the final core for analysis and put flag in the field application that indicates that the targeted recovery was not achieved.
    E. If an acceptable core cannot be collected within 3 feet of the node location, collect a ponar dredge sediment grab sample [refer to SOP-9: Vibracoring (which includes the use of a Ponar Dredge)] and note conditions preventing core collection in the field database.

12. After a successful core recovery enter prompted information into the field application:

    A. Date
    B. Time of recovery
    C. Actual coordinates of the sample location
    D. Water depth (ft)
    E. Core tube material (*e.g.*, Lexan®)
    F. Core penetration depth (inches)
    G. Observations, including probing results

13. Draw an arrow on the core tube with permanent marker to mark the top of the core. Label the core with waterproof label or permanent marker indicating station ID, date, and time.

14. Store the core vertically in a core tube cooler on ice. Use a tarp to keep the cores in the dark until they are transported to the field processing facility.

15. At locations where core samples cannot be collected, grab samples will be collected by lowering a ponar dredge until it comes in contact with the sediment and the release mechanism trips. Follow the grab sampling procedures in [refer to SOP-9: Vibracoring (which includes the use of a Ponar Dredge)].

16. Decontaminate the equipment and sampling tools according to decontamination procedures described in SOP 6: Decontamination of Soil Sampling Equipment.

17. At the end of each day, an electronic copy (disk) of the field application that includes the information recorded for each core sample collected that day will be created as a back up of that day's project information. This information will also be transmitted to the processing laboratory coordinator via duplicate copy or it will be uploaded to a website for download by the laboratory coordinator. Additionally, a hard copy of the field application will be printed out. The hard copy will serve as a back-up to the electronic copy, as well as the chain of custody form from the field to the processing laboratory. This form will be signed by sample collection personnel and core processing personnel at the time that the core processing personnel take custody of the cores. A copy of the signed field log form will be maintained in the processing laboratory.

IV. Reference

American Society for Testing and Materials (ASTM), 2000. Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes. Designation: D 1587-00.

Place Holder for SOP 14: X-radiograph Procedures

Place Holder for SOP 15: Density Profiler

Title: Infiltrex 300 Trace Organic Sampling

(Adapted from Axys Environmental Systems Operations Manual)

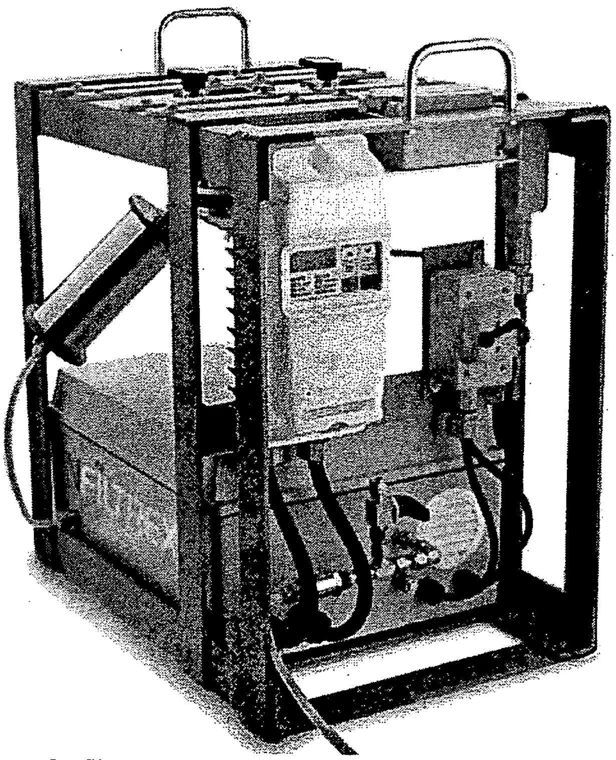


Photo of Infiltrex 300 Trace Organic Sampling System

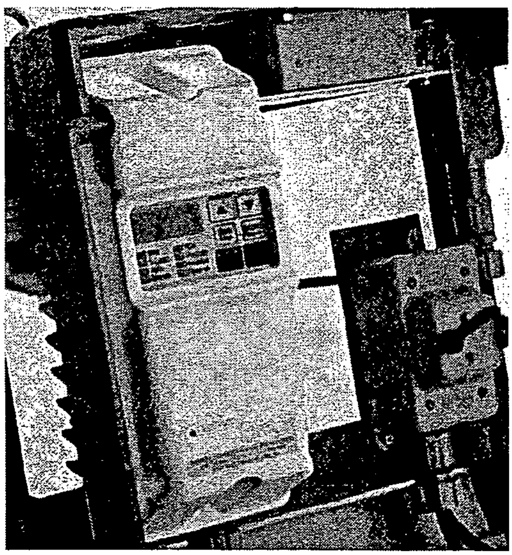
I. Introduction

This procedure describes the equipment and methods to be used to operate the Infiltrex 300 Trace Organic Sampling System (Infiltrex 300) for the collection of discrete filtered samples (organics) using an XAD-2 resin trap, and suspended solids samples produced during the filtering process. The Infiltrex 300 is a commercial version of the TOPS sampler (modeled after the INFILTREX) and is available from Axys Technologies. It can operate from any water sampling platform and removes solids and hydrophobic organic compounds (HOCs)/organometals from water samples in the field through the use of filters and XAD-2 traps. A lead-time of 2 or more weeks may be required when ordering filters and XAD-2 resin traps and filters. The Infiltrex 300 has been used for many years in multiple river systems (*e.g.*, Ohio River) similar in complexity to the Passaic River, with great success. It is a proven system for water column sampling when field filtering large water volumes (e.g., 20L to 1000L) is necessary.

II. Equipment

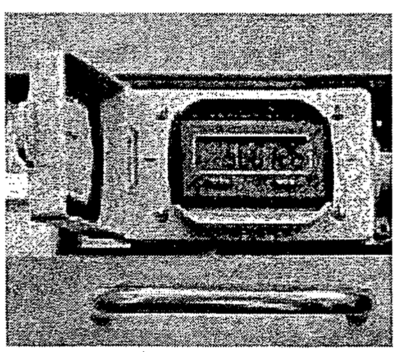
The Infiltrex 300 unit has the following components within a box frame:

1. Enclosure housing the Infiltrex 300 positive displacement, gear type pump (220 VAC), power supply, and flow meter (pump receives with feedback control from the flow meter). Flow meter is an optically sensed turbine with redundant volumetric logs (Watchman, Totalizer / rate meter) and a magnetic level switch.
2. Reliance Electric SP 500 3-Phase Variable Frequency Pump Motor Controller.



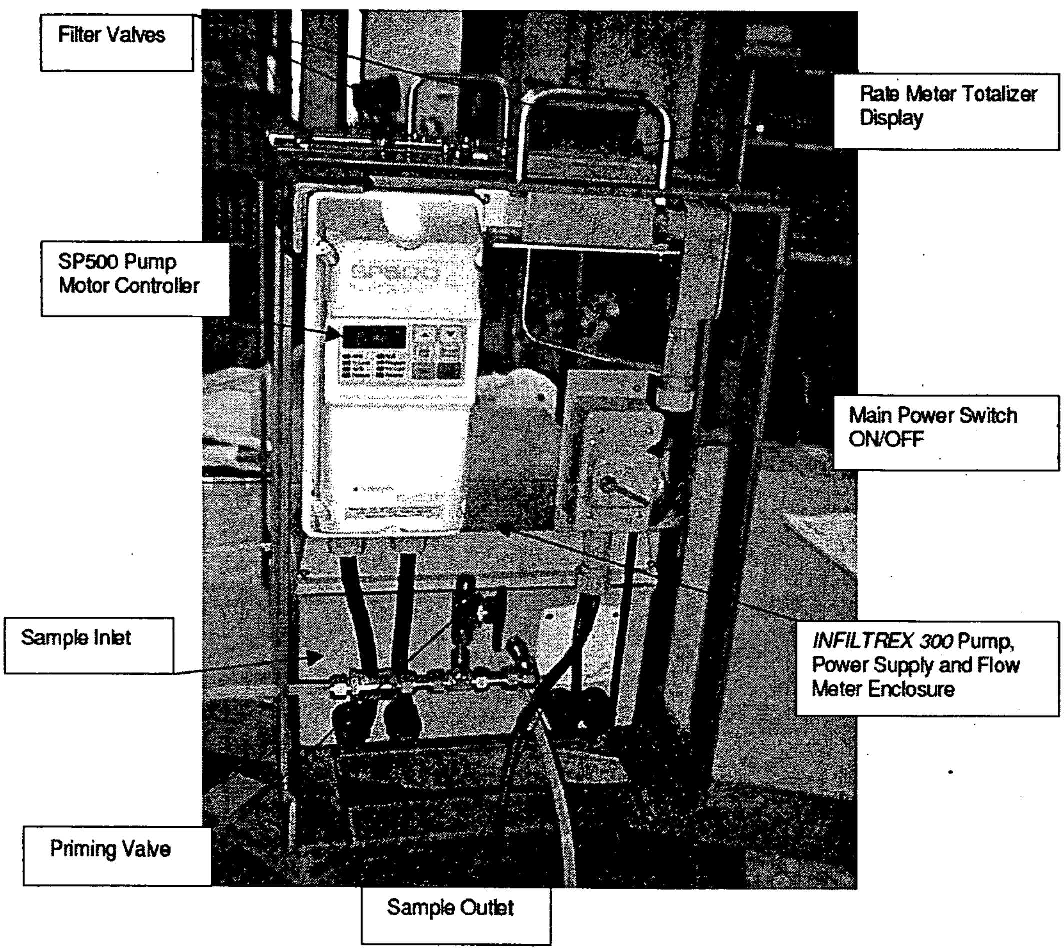
Pump Motor Controller and Main Power ON/OFF Switch

3. Main Power ON/OFF switch.
4. Rate Meter / Totalizer Display.



Totalizer/Rate Meter

5. Sample Inlet
6. Inline Filter/Screen
7. Inlet Flow Meter
8. Priming Valve
9. Sample Outlet
10. 4" Cartridge Filter Housings
11. Amberlite XAD-2 70-gram Extraction Column.
    or,
    XAD-2 250-gram Extraction Column
    Columns are available is either Teflon or stainless steel. Column selection is based on the anticipated concentrations in the water and the water volume to be pumped. Refer to the FSP for the column selection and optimal pumping rate/total volume.
12. Non-Contaminating Fluid Transfer Tubing.
13. User's Manual



Supplies:

1. Unopened Reels of Teflon or Teflon-lined High-Density Polyethylene (HDPE) (interior diameter of 3/8-inch, outside diameter of ½-inch). Needed to collected water samples from a pre-determined location within the river.

2. Inlet Screen to filter out large particles that may clog the system.

3. 5 to 10L Graduated Cylinder: to be filled with water after it passes through Infiltrex 300 for quality control check against the Infiltrex 300's totalizer.

4. Buoy and Anchoring Mechanism: Needed to establish sample locations within river and hold HDPE tubing in place while water sample collection activities are being performed.

5. Boat/Waders: needed to get to water sample location.

6. Personnel protective equipment (PPE): None (Aside from PFDs on boats, waders, and HASP PPE such as protective gloves.)

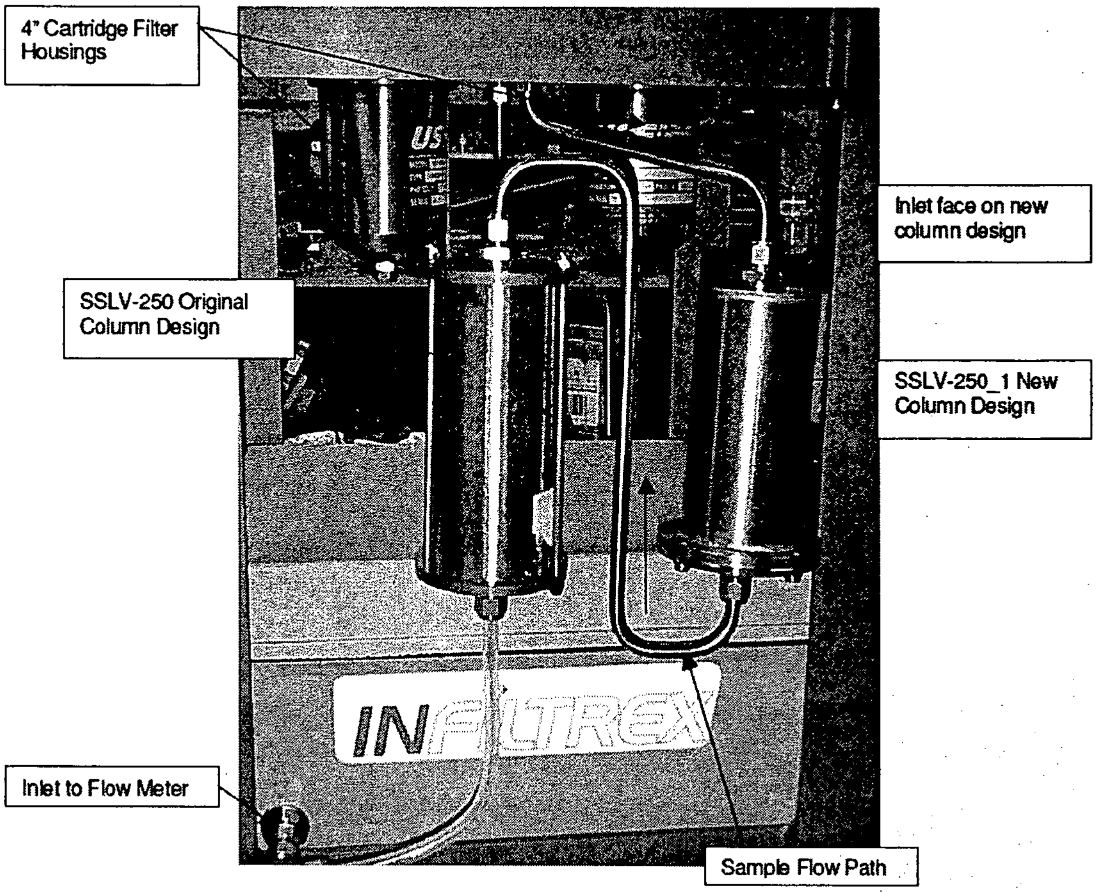
7. Electric generator or onboard 120VAC equipped with GFCI protection.

8. Miscellaneous Supplies – Garbage bags, decontamination supplies (Brushes, Liquinox, potable water, laboratory-grade deionized water) tape measure, field book, digital camera, field application equipment, deployment buoy, cooler, ice, and GPS.

III. Guidelines

Pre Sampling Procedures (XAD-2 Column – Installation/Removal):

XAD-2 Columns are shipped in clean, sealed bags separate from the Infiltrex 300 supplier. Immediately prior to sampling, remove the caps from the column fittings. These caps will be used later to seal the column, so they should be stored in a non-contaminating, sealed package. It is possible for a small amount of the alcohol or water buffer from the packaging process to be released when the end caps are removed. Always visually confirm the integrity of the retaining screen in each end before installing the columns on the instrument. Connect the fittings from the Infiltrex 300 tubing to the column fittings using the following procedures:



Connection of the XAD -2 70 Gram Teflon Column (See FSP for correct column size):

1. When ready to install, remove the caps from the ends of the column fittings. Remove only the nut from the end fitting – not the whole column end. The column end, which is also threaded, should not be removed in the field. It should only be removed to change the resin.
2. Push the tube directly into the column end fitting hole until it seats.
3. Hold it there and turn the fitting nut onto the threads until finger tight.
4. Pull back the tube lightly. It should move roughly a millimeter and stop as the grip inside the fitting nut drops into the groove on the tube.
5. Tighten the fitting nut ¾ of a turn beyond finger tight. Do not tighten further. Over tightening will damage the Teflon threads.

6. After all the tubing for the columns are connected and aligned, the tube fitting nuts should all be tightened securely, and checked.

Connection of the XAD -2 250 Gram Stainless Steel Column (See FSP for correct column size):

1. When ready to install, remove the caps from the ends of the column fittings. Remove only the nut from the end fitting – not the whole column end. The column end, which is also threaded, should not be removed in the field. It should only be removed to change the resin.
2. Push the tube directly into the column end fitting hole until it seats. There are two versions of the XAD-2 250 Gram Stainless Steel Column. The latest version of the XAD-2 250 Gram Stainless Steel Column is a welded unit that is not symmetrical and has only one end cap. The latest version of the XAD-2 250 Gram Stainless Steel Column has a flow path indicated on the end caps, showing "INLET" and "OUTLET". Be sure that the columns are not mounted upside-down otherwise, some of the solid phase resin may be lost.
3. Hold it there and turn the stainless steel Swagelok fitting nut onto the threads until finger tight.
4. Pull back the tube lightly. It should move roughly a millimeter and stop as the grip inside the fitting nut drops into the groove on the tube.
5. Tighten the fitting nut 1/2 of a turn beyond finger tight. Do not tighten further.
6. After all the tubing for the columns are connected and aligned, the tube fitting nuts should all be tightened securely, and checked.

Particle Filters – Installation:

A particulate cartridge–type filter is necessary for all actions since large volumes of water will be pumped. If any particulate matter is allowed to enter the column, it will soon coat the extraction material and either stop or greatly reduce the material's extraction efficiency. The cartridge-type filter for particulate removal prior to organic analysis (trace organic compounds) are wound glass fiber with a stainless steel core. Specifically, AXYS recommends a Heat Purified Glass Fiber Wound element (Product Number 1A4SE) made by Filterlite (301) 252-0080. These filters have a nominal 1 micron extraction capability.

1. Two cartridge filter housings are located on the top of the assembly and are opened by completely loosening the 1-inch, stainless steel nut. This will allow the lower stainless steel housing to be removed in order to access the used 4-inch cartridge or to load a new filter element.

2 When unloading filter elements, the filter bowl will contain water. Do not spill particulate-laden water if it is required for analysis. The recovered cartridge, plus residual water should be placed into a clean glass jar for analysis. A pre-cleaned wide-mouth glass jar will be used to hold the filters, standing water, and the wash-out from the filter holder. (Wash-out water is generated by using lab-certified water to rinse residual solids into the wide-mouth jar. Label the jar and enter the pertinent information into the Field Application.

In-Line Filter:

3 Prior to sample water entering the Infiltrex 300, it passes through an in-line 140-micron filter (or inlet screen). Algal growth and larger suspended solids within the Passaic River may reduce the efficiency of the sample flow rate. If the Infiltrex 300 pressure gauge is not registering pressure or is meandering at or below 5 psi, then stop the pump. At this point, switch to a back-up in-line (140 micron) filter by swapping them (takes less than 5 min). Piping entering the system can be split with an in-line control valve to divert sample water to a second in-line filter to reduce the amount of downtime. Place the used in-line filter into a laboratory-supplied glass jar and place within an iced cooler. Label the jar and enter the pertinent information into the Field Application. A decision may be made to analyze the particulates within the filter. Restart the pump and check the flow rate.

Deployment of Tubing for Sampling:

1. Prior to sample line deployment, acquire sampling locations using GPS and record location. Assess the need to set buoy in place prior to the day of the performing sampling with the Infiltrex 300 unit, if possible. This will permit rapid access to the proposed water sample location and minimize the amount of equipment carried the day of sampling. Sample locations will be co-located at SPMD deployment locations, where directed in the FSP.

   For the salt wedge water sample (brackish/saline water zone) location verify that the location is indeed within the salt wedge at the time of setting the anchoring mechanism, using a salinity meter. Salinity will not be as concentrated as the ocean, and will most likely be around 24 PPT, or less. Relocate as needed to assure that the sample will be collected in the salt wedge through the entire sample collection period as the tide recedes.

At sample locations requiring deployment in the salt wedge (2 feet above the river bottom), a weight (approximately 40 lbs) attached to a buoy will be dropped. From the weight 2' a rope section will be attached to a submerged float so that the end of Teflon (or equivalent) tubing (tubing inlet) will be positioned at 2 feet above the bottom.

For locations where a sample is to be collected 2 feet below the surface, the Teflon (or equivalent) tubing inlet will be suspended from the buoy (deployed as above). A small weight may be suspended from beneath the Teflon (or equivalent) tubing inlet, if necessary, to keep the tubing at a fixed position.

At locations where less than 5 feet of water is anticipated, anchoring mechanisms will consist of a rebar post driven into the sediment at least 3 feet, if possible. Since these locations are accessible by the public, and vandalism is possible, buoys will not be affixed to the rebar anchor. GPS readings will be taken, when possible.

In the event that GPS readings are not possible, due to trees or other overhead obstructions, measurements to nearby landmarks will be recorded. Compass direction or a description to the location will be recorded.

Devices for positioning Teflon (or equivalent) tubing shall be scrubbed in Alconox, rinsed with tap water, and wrapped in foil in preparation for Teflon (or equivalent) tubing deployment.

2. Deploying the Teflon (or equivalent) tubing: Become familiar with the following deployment procedures and prepare for the sequence that follows.

3. Keep the new Teflon (or equivalent) tubing within its shipping container/wrapping until it is transported to the river.

4. Travel to the pre-determined water sample buoy location, anchor the boat at a downstream location and **turn off the engine**. Make sure that the bow of the boat is adjacent to the proposed water sample location and that the boat engine is at the farthest possible down-wind location relative to the pre-determined water sample location. Check the GPS location and verify that the location has not moved. Different tidal cycles, or wind events, will create an artificial shift in the GPS location due to the position of the buoy. If in doubt, tug on the line to verify that the weight is securely in place. Adjust as necessary. (Shallow locations, especially in tributaries, will be waded to.)

6. After arriving at the deployment site and shutting-off the boat engine, make sure to shut-off generator or any other vapor emitting device. No fuel leaks or oily rags may be aboard the boat.

7. Teflon (or equivalent) tubing inlets will be deployed 2 feet from the surface in the channel of the Passaic River. At locations where there is 4 feet of water or less at low tide, Teflon (or equivalent) tubing inlets will be deployed at mid-depth of the anticipated low water depth. Record the water depth. At locations where saline and fresh water layers exist two sets of Teflon (or equivalent) tubing will be deployed: one 2' from the surface and one 2' from the river bottom.

8. Record all Horiba measurements using a calibrated meter.

9. For the salt wedge water sample (brackish/saline water zone) verify that the location is indeed within the salt wedge at the time of deployment and throughout the sample collection period. Salinity will not be as concentrated as the ocean, and will most likely be around 24 PPT.

10. <u>**While wearing clean gloves**</u>, remove the Teflon (or equivalent) tubing from its shipping container/wrapping. Note: Avoid allowing particulates to enter the tubing during installation. Particulates entering the Teflon (or equivalent) tubing could prematurely clog the Infiltrex 300's in-line filter and lessen the sample flow rate.

11. Attach a sufficient length of the Teflon (or equivalent) tubing (approximately 4-inches from the inlet opening) to the weighted lead line or buoy suspension line and submerge the tubing. Lower the tubing to the predetermined deployment depth.

12. Record GPS coordinates and time of deployment of the Teflon (or equivalent) tubing into the river.

13. Operate the Infiltrex 300 until the required volume of water has passed through the system. (See FSP for required volume.)

14. Attach sufficient length of tubing to the output portion of the Infiltrex system to allow a free range of tubing motion for filling graduated cylinders with water. During the pumping process, these cylinders are to be used as quantitative verification to check the actual pumped volume against the Infiltrex 300's totalizer volume.

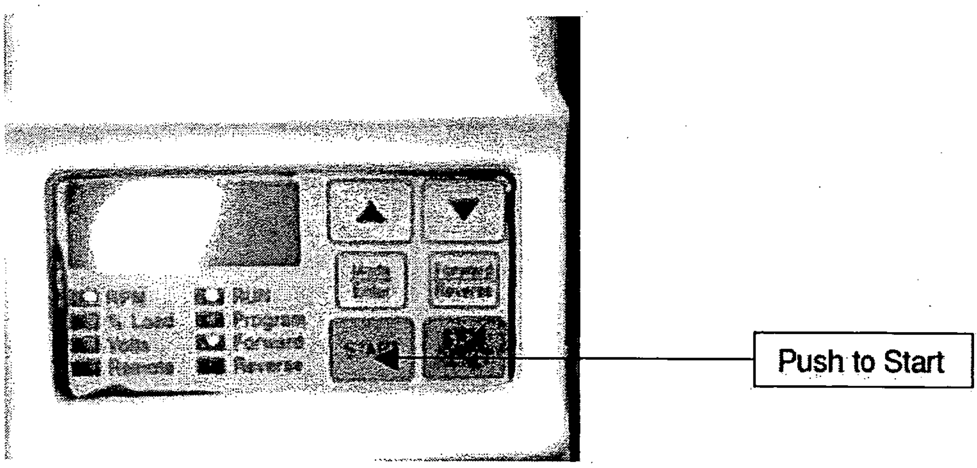
Initiation and Final Check:

Once the HDPE tubing is attached to the Infiltrex 300 inlet, the column and filter components have been assembled, and the fittings have been tightened, the operator initiates the sampling by starting the pump. The pumping sequence is started by:

1. Keeping the electrical generator exhaust at the furthest safe distance on the boat, start the generator. Be sure to have all proper GFCI protection devices in operable condition. Take note of the wind direction relative to the generator's exhaust.

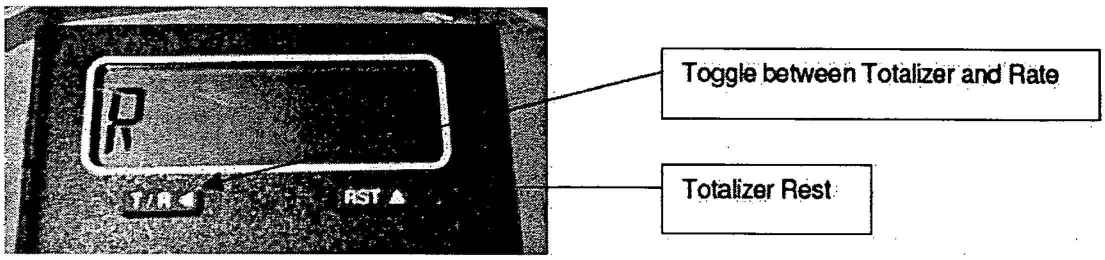
2. Turn the main power switch to "ON".

3. Press the "START" button on the SP500 control unit. Record the date and time that the Infiltrex 300 starts. Additionally, record ambient air temperature and weather conditions (*i.e.* sunny, air temperature 65 degrees Fahrenheit, wind south @ 10-15 mph).



4. The speed of the pump is controlled by pressing either the "UP" arrow to increase the Revolutions per Minute (RPM), or the "DOWN" arrow to reduce the RPM. The number displayed on the monitor is the motor RPM.
5. Three lights should be active in "Normal" sample mode "RPM", "RUN", and "FORWARD".

6. To stop a sample, press the "STOP" button on the controller and turn the power off.
7. To prime the system plumbing, a purge valve is located upstream of the inlet filter. Open the purge valve and add analyte free (de-ionized) water to fill the inlet piping and pump head prior to starting the sample.
8. Reset the totalizer meter located on top of the unit to zero at the start of a sampling event by pressing the reset switch. Once the Infilrex 300 is pumping, it is under the direct control of the operator who can manually adjust the sample stream flow rates to the desired values. A toggle switch on the totalizer display to change between "Totalizer" and Rate Meter." According to AXYS Technologies, the recommended sample flow rate for a 70-Gram column is between 100 ml/minute and 150 ml/minute. Axys technologies recommends the slower of the two above-mentioned sample flow rates for best efficiency of the 70-Gram column.



9. Stop the Infiltrex 300 pump at 20 liters (as also verified by the manually-filled graduated cylinder(s).

Column and Filter Removal:

Columns and filters will be sent to the laboratory for analysis. Adhere to the following procedure to prevent compromising the integrity of the column or filter.

1. After stopping the sampling process, turn off all switches and sources to the Infiltrex 300 unit. Remove the XAD-2 columns following the reverse of column installation process noted above.
2. Shut off generator.
3. Wearing new, clean Nitrile gloves, replace the end caps to each column. Make sure to use the original end caps removed and properly stored for each XAD-2 column. The column then can be stored up to three months prior to analysis with no special precautions.
4. Columns should not be frozen, as freezing can break down the extraction material and cause alterations in the blank levels and column performance.

5. If filters are to be analyzed, they must be handled with solvent cleaned metal tongs, wrapped in clean aluminum foil, and kept cooled until analyzed.

Field Blanks:

(Refer to the QAPP for Field Blank collection)

Field blanks can be taken for both the XAD-2 resin column and the glass fiber filter. Field blanks for the XAD-2 columns are collected by leaving both ends of a column open while the filled sample columns are being loaded into the sampler. Similarly, the two glass fiber filter blanks are collected by exposing a filter to the air while loading the sample filters into the cartridges. The field blank should receive the same analytical treatment in the laboratory as the field samples.

Retrieval after Sample Recovery:

1. Disconnect HDPE tubing from Infiltrex 300 inlet.
2. Remove HDPE tubing from the deployment line and coil in a manner that water in the tubing drains into the river.
3. Discard tubing into garbage bag and dispose of properly.
4. Run pump dry for a time until as much water as possible has been expelled from the Infiltrex 300 plumbing system.
5. As soon as convenient, after recovery of the inlet filter, filter cartridges, and XAD columns, potable water should be pumped through the Infiltrex 300 plumbing to flush out the remaining river water. This should be followed by flushing the system with a 10% methyl alcohol solution to sterilize the system. If there is a chance that the Infiltrex 300 will be stores below freezing, it should have a final rinse of pure methanol before being pumped dry so that any remaining liquid will not freeze.

IV. Deployment Locations

HDPE tubing for the collection of water samples via the Infiltrex 300 pump will be deployed at the locations, and at the depths, identified in the FSP.

V. References

Infiltrex 300 Trace Organic Sampling System User's Manual, Axys Environmental Systems, June 2002.

Jeanette Bedard, Customer Service, Axys Technologies, Inc.

Brian Fowler, Customer Service, Axys Technologies, Inc.

Prepared by: S. Cedro and C. Purkiss
Reviewed by: John Logigian

Title: Deployment and Retrieval of Semipermeable Membrane Devices

Adapted from Environmental Sampling Technologies deployment procedures.

I. Introduction

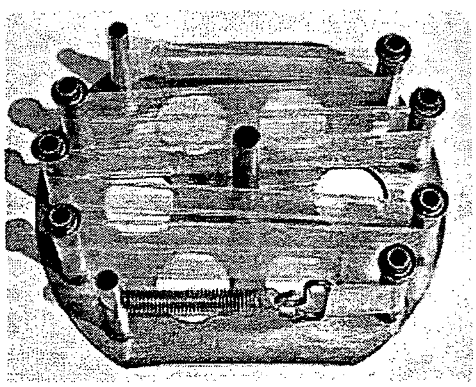
This procedure describes the equipment and methods to be used to deploy and retrieve semipermeable membrane devices (SPMDs). SPMDs are used as bioaccumulators of lipophilic environmental contaminants in aqueous, sediment, and atmospheric media. These devices mimic biological systems to provide a measure of bioavailable pollutants in both fresh and salt water. The passive transport mechanism is similar to that of fish gills and human lungs. The SPMD, however, unlike the typical biota used in pollution testing, does not metabolize the sequestered compounds, is site-specific, is much easier to extract, and will not overdose and die from the contamination it is supposed to be monitoring.

II. Equipment and Supplies

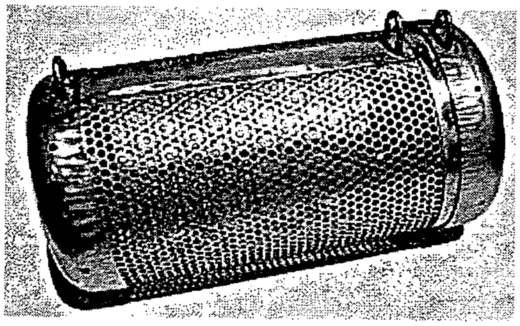
The following equipment will be needed to deploy and retrieve SPMDs:

1. SPMD tubing: composed of lay flat, low density polyethylene tubing containing a thin film of a pure, high-molecular weight lipid (triolein). The polymer, often thought to be non-permeable, actually consists of transport corridors of less than 10 Å in diameter. These pores allow for the selective diffusion of hydrophobic organic chemicals, which are then sequestered in the lipid phase.

2. 'Spider' Carrier: made of stainless steal, the SPMD tubing is put onto this carrier.



3. Deployment Canister: made of stainless steal, canisters can hold either 2 or 5 SPMD 'spider' carriers depending on the concentrations of contaminants present.



4. Buoy and Anchoring Mechanism: needed to locate SPMDs for retrieval and to hold SPMDs in place during high currents.

5. Boat/Waders: needed to get to measurement location.

6. Personnel protective equipment (PPE): None (Aside from PFDs on boats, waders, and HASP PPE such as protective gloves.)

7. Miscellaneous Supplies – Garbage bags, decontamination supplies (Brushes, Alconox, water) tape measure, field book, digital camera, field application equipment, rubber mallet, deployment buoy and pulley system, 100' tape measure, ice, and GPS.

III. Guidelines

Deployment

1. Prior to SPMD deployment: Acquire sampling locations using GPS and record location. Assess the need to set buoy in place prior to the day of SPMD deployment, if possible. This will permit rapid access to the proposed SPMD location and minimize the amount of equipment carried the day of deployment. At sample locations requiring deployment in the salt wedge (2 feet above the river bottom), a weight (approximately 40 lbs) attached to a buoy will be dropped. From the weight a rope section will be attached so that the SPMD will be positioned at 2 feet above the bottom. From the top of the deployment canister a submerged float will be used to maintain the deployment canister 2 feet above the river bottom.

   For locations where the deployment canister is to be located 2 feet below the surface the canister will be suspended from the buoy (deployed as above). A small weight may be suspended from beneath the canister, if necessary.

For the salt wedge SPMD (brackish/saline water zone) location verify that the location is indeed within the salt wedge at the time of setting the anchoring mechanism, using a salinity meter. Salinity will not be as concentrated as the ocean, and will most likely be around 24 PPT, or less. Relocate as needed.

At locations where less than 5 feet of water is anticipated, anchoring mechanisms will consist of a rebar post driven into the sediment at least 3 feet, if possible. Since these locations are accessible by the public, and vandalism is possible, buoys will not be affixed to the rebar anchor. GPS readings will be taken, when possible.

In the event that GPS readings are not possible, due to trees or other overhead obstructions, measurements to nearby landmarks will be recorded. Compass direction or a description to the location will be recorded.

SPMD deployment devices shall be scrubbed in Alconox, rinsed with tap water, and wrapped in foil in preparation for SPMD deployment.

2. Deploying the SPMDs: Become familiar with the following deployment procedures and prepare for the sequence that follows.

3. Keep SPMDs frozen in their shipping containers until they are transported to the river.

4. Transfer into a cooler and keep the SPMDs on ice until the time of deployment.

5. Travel to the SPMD buoy location, anchor the boat and **turn off the engine**. Check the GPS location and verify that the location has not moved. Different tidal cycles, or wind events, will create an artificial shift in the GPS location due to the position of the buoy. If in doubt, tug on the line to verify that the weight is securely in place. Adjust as necessary. (Shallow locations, especially in tributaries, will be waded to.)

6. After arriving at the deployment site and turning off the engine, generator or any other vapor emitting device. No fuel leaks or oily rags may be aboard the boat.

7. SPMDs will be deployed 2 feet from the surface in the channel of the Passaic River. At locations where there is 4 feet of water, or less, at low tide, SPMDs will be deployed at mid-depth of the anticipated low water depth. At locations where saline and fresh water layers exist two SPMDs will be deployed: one 2' from the surface and one 2' from the river bottom. At tributary locations an attempt will be

made to deploy SPMDs in an area where at least two feet of water exists. At Saddle River this will be in the pool formed by the dam, near the USGS gage station. At Third River this will be adjacent to the USGS gage station. At Second River a location upstream of the former USGS gage will need to be identified since low flow depths near the former USGS gage station are less than one foot.

8. Record the temperature of the river water, at the depth that the SPMD will be deployed, to be used later for concentration calculations. Record all Hariba measurements using a calibrated meter.

9. For the salt wedge SPMD (brackish/saline water zone) verify that the location is indeed within the salt wedge at the time of deployment. Salinity will not be as concentrated as the ocean, and will most likely be around 24 PPT.

10. Unscrew the lid on the deployment device. Some lids may give resistance, but the lid will unscrew. Note that there is a threaded rod in the center of the device. The spider carriers will slide into the device on this rod. The spiders can be placed in with the metal plate up or down. Place a twist-tie or other identifying mark on the deployment device indicating the salt wedge (lower) SPMD, so that at the location where two devices are deployed they will not be confused.

11. Begin timing how long it takes to deploy the SPMD: from the time the shipping can is opened until the SPMD enters the water. This time will be used to determine how long the Field Blank SPMD will be exposed to the air. (See Field Blank SPMD.)

12. Work open the gallon can with a church key (screwdrivers, etc. deform and damage the lid).When opening the SPMD shipping cans do not pry them open -- WORK them open carefully. A special opener is included to be used for this. It is imperative that the lid is not damaged or else the seal could be compromised.

    NOTE: All SPMDs will come attached to the spider holder. It may be necessary to scrub the deployment canister free of bio-fouling prior to redeployment of the canister.

13. **While wearing clean gloves**, remove the spider holder from the shipping can by grasping the spider carrier by either the metal plate or center post and lift slightly. Do **not touch the membranes - it could ruin the project**. Note that the there is a metal plate that has flaps that are bent upward. These flaps allow the carrier to slide out of the can diagonally. Gently turn and pull the carrier out of the can taking care not to damage or abrade the membrane. Reseal the shipping can.

14. While holding the spider carrier, slide the carrier into the deployment canister. Again, make sure that the threaded rod runs up through the carrier's center post (tube).

15. If no spacers are called for, and all the carriers are loaded, thread the lid back onto the canister. **CAUTION**- Start threading carefully. If there is resistance and the threads get crossed it could cost more expense in lost time. Please take care!

16. Be sure that the mounting ring on the lid matches with its opposing ring on the device body. These rings must be fastened together. Failure to do so could result in the lid unscrewing and dumping the spiders!

17. DO NOT HANDLE polyethylene membranes. Load the spider carrier(s) as rapidly as possible into deployment canister. Please make sure that the SPMDs are not punctured or abraded by sharp objects.

18. Attach the deployment canister to the weight lead line or buoy suspension line and submerge the canister. Mark the end time for exposure to the atmosphere. Lower the canister down to the predetermined deployment depth.

19. Record GPS coordinates, time of opening the SPMD shipping can, and time of deployment into the river.

20. FIELD BLANKS: One DEPLOYMENT SPMD FIELD BLANK, per deployment day, will be exposed to site atmosphere and conditions in a manner equivalent to the time the sample SPMDs are exposed. This means that if in one day 5 SPMDs are deployed and it takes approximately 5 minutes to deploy each SPMD, the Field Blank SPMD will be exposed for one minute at each location for a total exposure time not to exceed 5 minutes, or the time it takes to install one sample SPMD.

    One RETRIEVAL SPMD FIELD BLANK will be collected in reverse of the deployment field blank during SPMD retrieval.

    To expose each field blank: Open field blank can **CAREFULLY** with the supplied opener. The field blanks do not need to be removed from the cans. After exposure, **CAREFULLY RESEAL**, label, freeze, and document. Use a rubber mallet to replace lids by lightly tapping on the edges of the lid.

Retrieval

1. At arrival note GPS location and river water temperature.

2. When removing your SPMDs from their deployment devices, do the reverse of the above procedures. A rubber mallet is the best tool to use to seal the lids back on the cans in the field. Retrieval Field Blanks will be collected as detailed above, one per retrieval day. Note time that SPMD is out of the river, as described above.

3. Note in the field application the relative amount of bio-fouling on the retrieved SPMD membrane itself. Growth on the deployment canister, which does not impact the SPMD device, is not to be noted. Only in the event that the entire deployment device is obstructed with growth, or a plastic bag, or such, shall it be noted. .Samples should be packed in ice for return to the EST Laboratory, overnight. Several plastic soda bottles of frozen water have been shown to be sufficient for a two day trip.

IV. Deployment Locations

SPMDs will be deployed at the locations, and at the depths, identified in the FSP.

V. Reference

http://est-lab.com/spmd.php (Accessed 7-27-05).

Small Volume Grab Water Samples and Cross-Sectional Composite Sample Procedure

Adapted from information provided by Ultra-Clean Aqueous Sample Collection SOP by Frontier Geosciences

and

Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Criteria Levels, U.S. Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303), July 1996.

I. Introduction

This procedure describes the techniques used to collect multiple small volume water column composite grab samples from up to five locations at pre-determined transects across the Passaic River. Samples will be collected, composited, managed/preserved as required, and shipped to the laboratory on the day of collection. These samples should be collected simultaneously with respect to the other river transects. Samples collected for trace metals analysis will be collected utilizing "clean-hands" procedures described in this SOP and provided in detail in SOP 20 (with EPA Method 1669 attached). If the same pump and sampling tubing is to be used throughout the sample collection process, then the tubing must be handled in accordance with SOP-20: Ultra-Clean Water Sampling Procedures for Mercury.

Care will be taken to prevent contamination of the "clean hands" portion of the sampling.

II. Equipment and Supplies

1. Certified pre-cleaned sample containers large enough to obtain sufficient volumes of water for analysis at each sample site within the river transect. Sample containers must be Teflon, glass, high-density polyethylene (HDPE), low-density polyethylene LDPE, polycarbonate, or other bottles, as appropriate to the analytes of interest. Sample container composition and sizes are presented in the QAPP. The field team will add the appropriate type and volume of preservative to aqueous sample bottles prior to collection. The procedure for adding preservative is provided in the QAPP SOP-2. Samples requiring filtering will be filtered prior to chemical preservation.

2. Pre-packaged, tortuous-path disposable capsule filters for collecting dissolved metals samples. These filters must be provided by laboratory or equivalent clean source, and must be 0.45 micron (μm) in size. The filter must be compatible with the analyte to be filtered (e.g., zero carbon content for carbon analysis; non-protein binding filters for nitrogen). New filters will be used at each transect node during each of the three events for dissolved metals sample collection. (Maximum 15 filters per transect per event.)

3. Peristaltic pump (e.g., ISCO, Masterflex, or equivalent) that either has its own power supply (i.e. internal battery) or can be operated using an external battery (i.e. automobile battery or similar).

4. Silastic medical-grade peristaltic pump tubing (estimate up to 1 foot, to be used with each peristaltic pump head). During filtration the Silastic peristaltic pump tubing will be connected directly to the filter capsule. Prepared for "clean-hands."

5. Teflon or Teflon-lined tubing: used to draw river water for sampling. Prepared for "clean-hands."

6. Pole made of non-contaminating material: to be attached to the end of Teflon or Teflon-lined sample tubing for the collection of water samples when using a peristaltic pump. Add visible foot increments on pole. Prepared for "clean-hands."

7. Braided or monofilament nylon, line: to be used as lanyard to hold inlet of Teflon or Teflon-lined tubing in position while sampling water column.

8. Teflon weight for holding Teflon or Teflon-lined tubing in place. Do not use a lead or metallic weight if collecting metals samples. Prepared for "clean-hands."

9. Composite buckets comprised of non-contaminating material(s) for individual sample analysis. (**Composite buckets are an optional procedure that will not be used for this sampling.**) For duplicate sample collection a certified cleaned sample bottle will be used to collect the sample to be split between the sample and duplicate sample bottles. Similarly, this procedure shall also be used for obtaining the MS and MSD samples. See "Collecting water sample via peristaltic pump" Items Nos. 13 and 14, below, for proper sample volume collection.

10. Buoys: needed to locate water sample locations.

11. Boat/Waders: needed to get to water sample location.

12. Personnel protective equipment (PPE): Shoulder-length gloves constructed from non-contaminating material (i.e. Non-talc polyethylene). Also, PFDs on boats, waders, and HASP required PPE.

13. Nonmetallic coolers

14. Miscellaneous Supplies – Garbage bags, sample Ziploc bags, decontamination supplies (Brushes, Alconox, water) tape measure, field book, digital camera, field application equipment, deployment buoy, 100' tape measure, ice, and GPS.

15. Upon arriving at the sample site, one person from the two-person sampling team is designated as "dirty hands" and the second is designated "clean hands" **FOR SAMPLE COLLECTION FOR ALL METALS ANALYSIS.** All operations involving contact with the sample bottle and transfer of the sample from sample collection device to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is responsible for the preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample.

16. Hardcopy of EPA Method 1669: (Sampling Ambient Water for Trace Metals at EPA Water Levels, U.S. Environmental Protection Agency, Office of water Engineering and Analysis Division (4303), July 1996.

III. Guidelines

Prior to performing sampling methods:

1. Verify that composite container(s) is decontaminated per SOP 7: Decontamination of Water Sampling Equipment. Refer to SOP 20 for detailed "clean-hands" sample collection for Mercury.

2. Acquire appropriate certified pre-cleaned sample bottles for aqueous samples. For metals analysis, acquire appropriate "clean-hands" prepared sample containers, and pre-preserved "clean-hands" sample containers for filtered samples, from the appropriate laboratory as stipulated in EPA Method 1669. Verify that the sample containers are of the proper construction and volume for the associated analytical procedure.

3. Inspect all sample containers (and bags for "clean-hands") for defects or contamination. Inspect the vials for glass or septum defects (e.g., rim must not have nicks or visible depressions and the septum must not be deformed). Discard if defects are present or containers do not appear clean.

4. To reduce the potential for using incorrect sample containers for a particular analysis, create a checklist of analysis type (method) with regard to container size, material, and preservative required by a particular laboratory. (Also, refer to QAPP)

5. Prior to sampling, verify sampling locations using GPS and record location. Assess the need to set buoy in place prior to the day of sampling, if possible. This will permit rapid access to the proposed whole water sample location and minimize the amount of equipment carried the day of deployment.

Sampling Methodology: Three consecutive sampling events will be performed to collect water samples at each pre-determined location. Specifically, the first water sampling event will be performed one hour after high tide, the second sampling event two hours after the first sampling event, and the third sampling event two hours after the second sampling event.

Whole water samples will be collected at a pre-designated mid-point along the transect. Metals samples will be collected at up to 5 locations along specific river transects and composited. Please refer to FSP Volume 1 for exact water sampling locations. Become familiar with the following procedures and prepare for the sequence that follows.

1. Using a boat, travel to the pre-determined water sample buoy location, anchor the boat at a downstream location and **turn off the engine**. If possible, engine should be shut off at a distance far enough from the sampling point not likely to introduce contamination, and the boat should be manually moved to the sampling point (i.e., wooden oars).

2. Make sure that the bow of the boat is adjacent to the proposed water sample location and that the boat engine exhaust is at the farthest possible location relative to the pre-determined water sample location, preferably downwind. Check the GPS location and verify that the location has not moved. Different tidal cycles, or wind events, will create an artificial shift in the GPS location due to the position of the buoy. If in doubt, tug on the line to verify that the weight is securely in place. Adjust as necessary. (Shallow locations, especially in tributaries, will be waded to.)

3. After arriving at the pre-determined water sample location and shutting-off the boat engine, make sure to shut-off generator or any other vapor emitting device. No fuel leaks or oily rags may be aboard the boat.

4. When wading, position yourself to collect samples upstream from the body. Avoid disturbing sediments in immediate area of sample collection.

5. **Wear appropriate clean Nitrile gloves, or "clean-hands" gloves, as required, at all times.**

6. Measure the water column to determine the maximum depth and the sampling depth.

7. Water samples will be collected at 2 feet below the river surface and/or 2 feet above the river bottom at the predetermined transect site.

Collecting water sample via peristaltic pump:

1. Before putting on wind suits or gloves, the field team removes bags containing the pump, tubing, battery(ies), wind suits, and plastic wrap.

2. Record all Horiba measurements using a calibrated meter.

3. For the salt wedge water sample (brackish/saline water zone) verify that the location is indeed within the salt wedge throughout the time of deployment. Salinity will not be as concentrated as the ocean, and will most likely be around 24 PPT.

2. "Clean hands" and "dirty hands" put on the wind suits and protective gloves.

3. "Dirty hands" removes the pump from its storage bag, and opens the bag containing the Teflon or Teflon-lined tubing.

4. "Clean hands" installs the tubing while "dirty hands" holds the pump.

5. "Clean hands" installs the Teflon or Teflon-lined tubing to a clean pole or to the deconned Teflon weight. Place sufficient amount of string between the Teflon or Teflon-lined tubing so that it the inlet of the Teflon or Teflon-lined tubing is at the desired sampling depth.

6. "Dirty hands" submerges the pole and the end of the Teflon or Teflon-lined sampling tubing to the desired depth.

7. Both "clean hands" and "dirty hands" change gloves. "Clean hands" also puts on shoulder length polyethylene gloves.

8. "Dirty hands" turns the pump on and allows the pump to run for 5-10 minutes or longer to purge the pump and tubing.

9. "Dirty hands" must open the cooler or storage container, remove the double-bagged sample bottle from storage, and unzip the outer bag.

10. Next, "clean hands" opens the inside bag containing the sample bottle, removes the bottle, and reseals the inside bag. "Dirty hands" then reseals the outside bag.

11. "Clean hands" unscrews the cap, and while holding the cap upside-down, discards the dilute acid solution from the bottle into a carboy for wastes.

12a.If the bottle is unpreserved from the laboratory, the sample is collected by rinsing the sample bottle and bottle cap three times and collecting the sample from the flowing stream. "Clean hands" then replaces the cap of the sample bottle.

12b.If the bottle is preserved from the laboratory, the sample is collected directly into the bottle from the flowing stream. "Clean hands" then replaces the cap of the sample bottle.

13. Collection of composite water samples: While pump is running, "clean hands" pumps proportional sample water volumes at each node along the transect directly into the sample bottles from discharge end of Teflon or Teflon-lined tubing from peristaltic pump. With known pump flow rate (timed using a graduated cylinder during the 5 to 10 minute purge period), time the duration of pump filling the sample containers. Therefore, equal volumes of river water from sample locations across river transect will be directed into the sample containers, keeping in mind the volume of water that is needed to fill sample containers that will be submitted to the laboratory (ies) for analysis.

    Example: Three samples will be collected at each transect beginning 1 hour after high tide, and continuing at two hour intervals thereafter until the three samples are obtained. For each of the three sampling periods, 5 locations across each transect are to be collected, where possible. (This will be reduced at tributary locations.) To collect one sample 1/5 of the total volume required for analysis will be pumped into each sample container, if 5 locations are utilized. At the end of each transect each sample bottle will have been properly filled. "Clean hands" will replace the cap of the sample bottle after the composite water aliquot is added to the bottle.

14. For dissolved (field filtered) metals: "Clean hands" connects the capsule filter to the discharge end of the peristaltic pump. "Dirty hands" starts pump and sends sufficient sample water through the capsule filter to rinse it. "Dirty hands" stops the pump. (Collect this sample water into a container for IDW disposal, if the filter contained laboratory decon fluid.) "Clean hands" places discharge from capsule filter over appropriate open sample bottle (open sample bottle per Items 12a and 12b above) and begins to fill the sample container. Follow Item 13 above for collecting composite water samples. **Note: A new capsule filter must be used at each sample location.**

15. Once the bottle lid has been replaced, "dirty hands" re-opens the outer bag and "clean hands" opens the inside bag, places the bottle inside it, and zips the inner bag.

16. "Dirty hands" zips the outer bag.

17. After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

18. If preservation is required, the sample is taken immediately to the "clean room" where it is acidified with appropriate preservative at this point as described in the QAPP (See SOP 2 for Sample Preservation).

19. Use the same "clean hands" and "dirty hands" methodology mentioned above when handling the sample bottles for the addition of preservatives.

20. Immediately place samples on ice and submit to laboratory.

21. Repeat this process for each consecutive sampling event.

IV. Water Sample Collection Locations

Water samples will be collected at the locations, and at the depths, identified in the FSP.

V. References

Ultra-Clean Aqueous Sample Collection FGS-008.3, Frontier Geosciences, Seattle, WA, November 15, 2001.

Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Criteria Levels, U.S. Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303), July 1996.

Prepared by: David Arnold
Reviewed by: John Logigian

Title: Procedure for 5L Niskin Bottle Use

Adapted from information provided by General Oceanics website and interviews with General Oceanics personnel.

I. Introduction

This procedure describes the methods to be used to deploy and retrieve whole water samples using 5L Niskin bottles, or different size Niskin bottles of similar construction and composition. Niskin bottles are non-metallic, free-flushing sampling bottles activated by GO Devil messenger (1000-mg) when individually or serially attached to a cable (string/twine, etc.) The upgraded Niskin bottles have stoppers at each end which are held in place by stainless steel springs and have Teflon coating inside the sampler and on the exterior springs. Additionally, seals are constructed of Viton and air vents and sampling ports are constructed of Teflon. The Niskin bottles are easily used to collect water samples across a river channel transect provided no field sample preparation is required. Generally, a composite of multiple samples from the 5L Niskin bottles are transferred into a 20L stainless steel POP container, which is placed on ice and transported directly to the analytical laboratory.

II. Equipment

The 5L Niskin bottles have the following components:

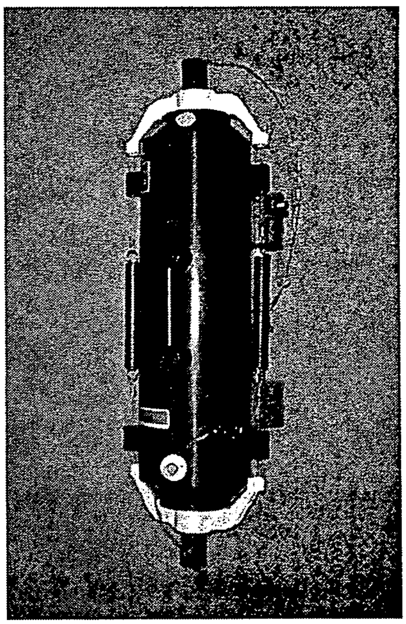


Photo of Niskin-X External Spring Sampler

1. Non-Metallic construction of PVC tube section. Teflon coating is added to interior of PVC tube.
2. PVC end stoppers (two each). Teflon coating is added to interior portions of end stoppers.
3. PVC handles
4. Stainless steel cable clamps with external springs
5. Teflon-coated Deldrin stopcocks
6. Teflon air vent screw
7. Teflon drain valve
8. Viton o-rings
9. Nylon monofilament lanyards
10. End closure stopper with spherical section sealing surface held firmly against o-ring seal by external stainless springs.
11. GO Devil (1000 mg) messenger

III. Supplies:

1. Nylon rope (or similar rope/line) having a diameter fitting inside the center of the GO Devil messenger.
2. Buoys: needed to locate water sample locations.

3. Boat/Waders: needed to get to measurement location.

4. Personnel protective equipment (PPE): None (Aside from PFDs on boats, waders, and HASP PPE such as protective gloves.)

5. Miscellaneous Supplies – Garbage bags, decontamination supplies (Brushes, Alconox, water) tape measure, field book, digital camera, field application equipment, rubber mallet, deployment buoy and pulley system, 100' tape measure, ice, and GPS.

IV. Guidelines

1. Prior to 5L Niskin bottle deployment: Acquire sampling locations using GPS and record location. Assess the need to set buoy in place prior to the day of 5L Niskin bottle deployment, if possible. This will permit rapid access to the proposed whole water sample location and minimize the amount of equipment carried the day of deployment.

2. Using non-contaminating markers or tape, place 1-foot marks on rope/twine attached to the 5L Niskin bottles for accurate depth placement for the collection of whole water samples. Attach rope/twine per manufacturer's specifications to attachment point in 5L Niskin bottle. Be sure to thread GO Devil messenger device onto rope/twine prior to attaching rope/twine to 5L Niskin bottle.

3. Keep stoppers closed on both ends of clean (deconned) 5L Niskin bottle until it is ready for deployment. Clean (deconned) 5L Niskin bottles should also be kept in a plastic bag until ready for use.

Deploying and Retrieving the 5L Niskin bottles: Become familiar with the following deployment procedures and prepare for the sequence that follows. 5L Niskin bottles will be required for collecting whole (total) water.

1. Travel to the pre-determined water sample buoy location, anchor the boat at a down current location and **turn off the engine**. Make sure that the bow of the

boat is adjacent to the proposed water sample location and that the boat engine is at the farthest possible location relative to the pre-determined water sample location, preferably downwind. Check the GPS location and verify that the location has not moved. Different tidal cycles, or wind events, will create an artificial shift in the GPS location due to the position of the buoy. If in doubt, tug on the line to verify that the weight is securely in place. Adjust as necessary. (Shallow locations, especially in tributaries, will be waded to.)

4. After arriving at the deployment site and shutting-off the boat engine, make sure to shut-off generator or any other vapor emitting device. No fuel leaks or rags may be aboard the boat.

5. Obtain total depth of water column using a weighted graded device (*e.g.* graded nylon string with weight.

6. 5L Niskin bottles will be deployed 2 feet from the surface in the channel of the Passaic River. At locations where saline and fresh water layers exist of the same 5L Niskin bottle will be deployed: one collection 2' from the surface and one collection 2' from the river bottom.

7. Record the temperature of the river water, at the depth that the 5L Niskin bottles will be deployed, to be used later for concentration calculations. Record all Horiba measurements using a calibrated meter.

8. For the salt wedge water sample (brackish/saline water zone) verify that the location is indeed within the salt wedge at the time of deployment. Salinity will not be as concentrated as the ocean, and will most likely be around 24 PPT.

9. **Wear clean gloves while performing any tasks requiring contact with 5L Niskin bottles, related sample containers, and rope/twine.**

10. Open 5L Niskin bottles by tuning open both end stoppers and placing attached nylon monofilament lanyards between side pegs. The nylon monofilament line will automatically rest against the side of the peg that is away from the end stopper from which it is attached. **Be sure that the drain valve is in a closed position!**

Photo of open end of 5L Niskin bottle.

11. While holding rope/twine attached to 5L Niskin bottle, gently place 5L Niskin bottle into river and slowly lower to the appropriate depth for sample collection. When at the desired sample depth (using graded rope/twine), allow water to flush through the Niskin 5L bottle for a minimum of 10 seconds. This will allow the interior of the 5L Niskin bottle to rinse and allow material from the water surface which may have been lowered at depth by the 5L Niskin bottle to leave the vicinity of the 5L Niskin bottle. **Be sure to keep the Go Devil messenger in hand at a position above the water surface while each 5L Niskin bottle is lowered.**

12. Record GPS coordinates and time of deployment of the 5L Niskin bottles into the river.

13. When at the desired sampling depth, drop the Go Devil messengers simultaneously into the water toward the 5L Niskin bottle. The Go Devil

messengers will contact a trip mechanism on each 5L Niskin bottle, if two are deployed simultaneously, which will then close both stoppers.

14. Gently pull the 5L Niskin bottle(s) up from the water column using the rope/twine. Separate 5L whole water column samples will be collected four times throughout the duration of the Infiltrex 300 water sample filtering process at the particular station for both total (Niskin bottle) and field filtered (INFILTREX - without XAD column) water samples.

15. Making sure that the boat motor is at the farthest possible location from water sample location, start the boat and slowly and carefully bring the boat anchor(s) back to the boat. Make all attempts possible not to increase the water column turbidity. **Gently rinse sediment off of anchor before bringing it aboard.**

16. Slowly maneuver the boat at a down current position from the pre-determined water sample to transport water sample back to shore.

17. Whole Water Samples: Immediately place water sample from 5L Niskin bottle used for total analysis directly into a clean (deconned) 20L stainless steel POP container. Securely attach lid on the 20L POP container and place the 20L POP container directly on ice. Be sure to wear proper gloves and PPE throughout the process.

18. Filtered Water Samples: Lower a Teflon, or Teflon lined, tubing to the elevation required for sample collection at the location. Filter the water using the INFILTREX using it in a configuration without the XAD column. Therefore the INFILTREX will be operated for field filtering particulates only. Turn on pump and draw sample from river through the filter and pump and discharge the filtered sample into a clean (deconned) 20L stainless steel POP container. Securely attach lid on the 20L POP container and place the 20L POP container directly on ice. Be sure to wear proper gloves and PPE throughout the process.

19. Follow deconning SOPs for the 5L Niskin bottles prior to retrieving additional water samples from a different sampling location. Note: The same Niskin bottle may be used to obtain fresh and salt water samples at the same sampling location.

V. Deployment Locations

5L Niskin bottles will be deployed at the locations, and at the depths, identified in the FSP.

VI. References

http://www.generaloceanics.com (Accessed 8-10-05)

Rick Wood, General Oceanics, Inc.

Ultra-Clean Water Sampling Procedures for Mercury

Adapted from information provided by Ultra-Clean Aqueous Sample Collection SOP by Frontier Geosciences

and

Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Criteria Levels, U.S. Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303), July 1996.

I. Introduction

This procedure describes the techniques used to obtain water samples for mercury analysis using Ultra-Clean Water Sampling Procedures. Mercury will be collected from up to two depth increments at up to five locations at pre-determined transects across the Passaic River. Samples will be collected to represent the cross section, managed as required, and shipped to the laboratory on the day of collection. These samples should be collected simultaneously with respect to each other.

II. Equipment and Supplies

1. Laboratory-supplied sample containers large enough to obtain sufficient volumes of water for analysis at each sample site within the river transect. Sample containers must be of Fluoropolymer or borosilicate glass construction with fluoropolymer or fluoropolymer-lined caps, since mercury vapors can diffuse in or out of other materials, resulting in contamination or low-biased results. All materials that will directly or indirectly contact the sample must be cleaned at a laboratory or cleaning facility using detergent, mineral acids, and reagent water as described in EPA Method 1631 for Mercury. The laboratory or cleaning facility is responsible for generating an equipment blank indicating that the sample containers and sampling equipment are free of trace metals contamination before they are shipped to the field team. An acceptable blank for mercury is free from contamination below the minimum level (ML) of 0.0005 micrograms per liter (μg/L). After cleaning, all sample containers are filled with a weak acid solution, individually double bagged, and shipped to the sampling site. All sampling equipment is also bagged for storage and shipment.

2. Carboy or other clean sample container filled with reagent water. For use with the collection of equipment blanks. The reagent water is to be handled the same as the

sampling containers. At least one field blank should be processed per site, or one every 10 samples, whichever is more frequent.

3. Peristaltic pump (e.g., ISCO, Masterflex, or equivalent): Either has its own power supply (i.e. internal battery) or can be operated using an external battery (*i.e.* automobile battery or similar).

4. Silastic medical-grade peristaltic pump tubing (estimate up to 1 foot to be used with each peristaltic pump head). Small segments of this tubing can also be used to join Teflon or Teflon-lined tubing to flow-thru cells, in-line sample filters, etc.

5. Teflon or Teflon-lined tubing: used to draw river water for sampling.

6. Pole made of non-contaminating material: to be attached to the end of Teflon or Teflon-lined sample tubing for the collection of water samples when using a peristaltic pump. Add visible foot increments on pole.

7. Laboratory–supplied grab sampling device: <u>To be used as an alternative for collecting shallow water samples.</u>

8. Braided or monofilament nylon, line: to be used as lanyard to hold inlet of Teflon or Teflon-lined tubing in position while sampling water column.

9. Teflon weight for holding Teflon or Teflon-lined tubing in place. Do not use a lead or metallic weight if collecting metals samples. Prepared for "clean-hands."

10. Field-portable glove-bag: I2R, Model R37-37H (nontalc), or equivalent. Additionally, a portable glove-box may be constructed with a non-metallic (PVC or other suitable material) frame, and frame cover made of an inexpensive, disposable, non-metallic material (*e.g.*, thin-walled polyethylene bag).

11. Storage bags: clean zip type, non-vented, polyethylene type (various sizes).

12. Plastic wrap: clean, colorless polyethylene.

13. Cooler: clean nonmetallic with white interior.

14. Ice or chemical refrigerant packs.

15. Wind suit: unlined, long-sleeved consisting of pants and jacket constructed of nylon or other synthetic fabric.

16. If boat is used, it is recommended to be of non-metallic construction.

17. Buoys: needed to locate water sample locations.

18. Boat/Waders: needed to get to water sample location.

19. Personnel protective equipment (PPE): Shoulder-length gloves constructed from non-contaminating material (*i.e.* polyethylene). Also, PFDs on boats, waders, and HASP PPE such as protective gloves.

20. Miscellaneous Supplies – Garbage bags, decontamination supplies (Brushes, Alconox, water) tape measure, field book, digital camera, field application equipment, rubber mallet, deployment buoy and pulley system, 100' tape measure, ice, and GPS.

21. Hardcopy of EPA Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Levels, U.S. Environmental Protection Agency, Office of water Engineering and Analysis Division (4303), July 1996.

III. Guidelines

Prior to performing sampling methods:

1. Acquire appropriate preserved sample containers from the appropriate laboratory. Verify that the sample containers are of the proper construction and volume for the associated analytical procedure.

2. Inspect all sample containers for defects or contamination. Discard if defects are present or containers do not appear clean.

3. Prior to sampling, verify sampling locations using GPS and record location. Assess the need to set buoy in place prior to the day of sampling, if possible. This will permit rapid access to the proposed whole water sample location and minimize the amount of equipment carried the day of deployment.

Sampling Methodology: Become familiar with the following procedures and prepare for the sequence that follows.

1. Using a boat, travel to the pre-determined water sample buoy location, anchor the boat at a downstream location and **turn off the engine**. If possible, engine should be shut off at a distance far enough from the sampling point not likely to introduce contamination, and the boat should be manually moved to the sampling point (*i.e.*, wooden oars).

2. Make sure that the bow of the boat is adjacent to the proposed water sample location and that the boat engine is at the farthest possible location relative to the pre-determined water sample location, preferably downwind. Check the GPS location and verify that the location has not moved. Different tidal cycles, or wind events, will create an artificial shift in the GPS location due to the position of the buoy. If in doubt, tug on the line to verify that the weight is securely in place. Adjust as necessary. (Shallow locations, especially in tributaries, will be waded to.)

3. After arriving at the pre-determined water sample location and shutting-off the boat engine, make sure to shut-off generator or any other vapor emitting device. No fuel leaks or rags may be aboard the boat.

4. When wading, position yourself to collect samples upstream from the body. Avoid disturbing sediments in immediate area of sample collection.

5. Upon arriving at the sample site, one person from the two-person sampling team is designated as "dirty hands" and the second is designated "clean hands." All operations involving contact with the sample bottle and transfer of the sample from sample collection device to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is responsible for the preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample.

The following two methods may be used for the collection of the water sample for mercury:

Collecting water sample via grab sampling device:

1. The sampling team puts on gloves and wind suits. Ideally, a sample bottle will have been pre-attached to the sampling device in a Class 100 clean room at the

laboratory. If it is necessary to attach a bottle to the device in the field, "clean hands" performs this operation inside the field-portable glove bag.

2. "Dirty hands" removes the sampling device from its storage container and opens the outer polyethylene bag.

3. "Clean hands" opens the inside polyethylene bag and removes the sampling device.

4. "Clean hands" changes gloves.

5. "Dirty hands" submerges the sampling device to the desired depth and pulls the fluoropolymer cord to bring the seal plate into the middle position so that water can enter the bottle.

6. When bottle is full, (*i.e.*, when no more air bubbles appear), "dirty hands" pulls the bottle out of the collar, unscrews the bottle from the sealing device, and caps the bottle. "Clean hands" and "dirty hands" then return the bottle to its double-bagged storage by having "dirty hands" re-open the outer bag and "clean hands" opens the inside bag, places the bottle inside it, and zips the inner bag. "Dirty hands" then zips the outer bag.

7. Closing mechanism- "Clean hands removes the closing mechanism from the body of the grab sampler, rinses the device with reagent water, places it inside a new clean plastic bag, zips the bag, and places the bag inside an outer bag by "dirty hands." "Dirty hands" zips the outer bag and places the double-bagged closing mechanism into the equipment storage box.

8. Sampling device- "Clean hands" seals the large inside bag containing the collar, pole, and cord and places the bag into a large outer bag held by "dirty hands." "Dirty hands" seals the outside bag and places the double-bagged sampling device into the equipment storage box.

9. After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

10. Immediately place samples on ice and submit to laboratory.

Collecting water sample via peristaltic pump:

1. Before putting on wind suits or gloves, the field team removes bags containing the pump, tubing, battery(ies), wind suits, and plastic wrap.

2. "Clean hands" and "dirty hands" put on the wind suits and protective gloves.

3. "Dirty hands" removes the pump from its storage bag, and opens the bag containing the Teflon or Teflon-lined tubing.

4. "Clean hands" installs the tubing while "dirty hands" holds the pump.

5. "Clean hands" installs the pump to a clean pole (pre-cleaned as prescribed in EPA Method 1631 for Mercury).

6. "Dirty hands" submerges the pole and end of the Teflon or Teflon-lined sampling tubing to the desired depth

7. Both "clean hands" and "dirty hands" change gloves. "Clean hands" also puts on shoulder lengthy polyethylene gloves.

8. "Dirty hands" turns the pump on and allows the pump to run for 5-10 minutes or longer to purge the pump and tubing.

9. "Dirty hands" must open the cooler or storage container, removed the double-bagged sample bottle from storage, and unzip the outer bag.

10. Next, "clean hands" opens the inside bag containing the sample bottle, removes the bottle, and reseals the inside bag. "Dirty hands" then reseals the outside bag.

11. "Clean hands" unscrews the cap, and while holding the cap upside-down, discards the dilute acid solution from the bottle into a carboy for wastes.

12. If the sample bottle has no preservative from the laboratory, the sample is collected by rinsing the sample bottle and bottle cap three times and collecting the sample from the flowing stream. If the sample bottle has preservative from the laboratory, it is filled directly from the flowing stream and not rinsed. Because of the risk of contamination, it is recommended that samples of mercury be shipped **unfiltered** by overnight courier and filtered when received at the laboratory. If preservation is required, the sample is acidified with appropriate preservative at this point. Preservation must be performed in the glove bag or in a designated

clean area, with gloved hands, as rapidly as possible to preclude particulates from contaminating the sample.

13. "Clean hands" then replaces the cap of the sample bottle.

14. Once the bottle lid has been replaced, "dirty hands" re-opens the outer bag and "clean hands" opens the inside bag, places the bottle inside it, and zips the inner bag.

15. "Dirty hands" zips the outer bag.

16. After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

17. Immediately place samples on ice and submit to laboratory.

IV. Water Sample Collection Locations

Water samples will be collected at the locations, and at the depths, identified in the FSP.

V. References

Ultra-Clean Aqueous Sample Collection FGS-008.3, Frontier Geosciences, Seattle, WA, November 15, 2001.

Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Criteria Levels, U.S. Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303), July 1996.

Method 1631 Revision E: Mercury in Water by Oxidation, Purge Trap, and Cold Vapor Atomic Fluorescence Spectronomy, US Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303), August 2002.

Title: Horiba Use for Measuring Water Parameters

Adapted from Horiba Ltd U-10 Water Quality Checker Instruction Manual.

I. Introduction

This procedure describes the equipment and methods to be used collect and process water quality data using a Horiba U-10 Water Quality Checker. The Horiba U-10 Water quality checker can be used to collect conductivity, turbidity, salinity, temperature, dissolved oxygen, and pH in water.

II. Equipment and Supplies

The following equipment is required to collect and store water quality data:

1. Horiba U-10 Main Unit which contains:
    A. Cover for printer port.
    B. Printer Post.
    C. LCD Readout.
    D. Keypad.
    E. Cable Connector.
2. Horiba U-10 Cable
3. Horiba U-10 Probe which contains:
    A. Dissolved Oxygen (DO) Sensor.
    B. Conductivity Sensor.
    C. Reference Sensor.
    D. Temperature Sensor.
    E. pH Sensor.
    F. Turbidity Sensor.
    G. Probe Guard.
4. Horiba U-10 Sample/Calibration Beaker.

5. Laptop computer with instrument interface software, field sampling data collection application.
6. 9-Volt battery for the instrument.
7. Vessel with DGPS navigation system.
8. Personal safety gear: including personal flotation devices (PFDs), waterproof outer wear, steel toed boots (waterproof if rough seas or weather), and mobile phone.
9. Calibration materials/solutions
10. Station logs, indelible markers/pens (*e.g.*, Sharpies™).
11. Horiba U-10 Instruction Manual.

III. Guidelines

1. Be sure to read and become familiar with the Horiba U-10 Instruction Manual.

2. Prior to field use, inspect probes on the bottom of the Horiba U-10 to verify that no cracks, discolorations, etc, exist on or around the probes.

3. Calibrate the Horiba U-10 per the manufacture's specifications (see Section 3, Horiba U-10 Instruction Manual). Keep in mind that pH and DO values change with temperature. Note pre calibration values, and instrument voltage settings post-calibration values in field application or instrument logbook. Calibrate Horiba U-10 as frequently as recommended by the manufacturer.

4. Clean the Horiba U-10 sample/calibration beaker and probes as specified in SOP-7: Decontamination of Water Sampling Equipment. Be sure to rinse the probes thoroughly with water. This should be performed prior to arriving at each sample location.

5. Turn the power for the Horiba U-10 to "On." The Horiba U-10 will be in the measure "MEAS" mode. After approximately 2 seconds, the Horiba U-10 readout will change to show that a new measurement is being made. Use the "SELECT" key to toggle the upper cursor to the parameter needed.

6. Prior to collecting water samples for laboratory analysis, place river water from the pump or other collection device/method directly into the Horiba U-10 sample/calibration beaker. Fill beaker to level specified by the manufacturer.

7. Place the Horiba U-10 probes directly into the Horiba U-10 sample/calibration beaker. All six parameters (DO, conductivity, temperature, pH, turbidity, and salinity) are measured instantly. Use the "SELECT" key to toggle the upper cursor to the parameter needed. These parameters may be stored in memory, printed-out, or viewed one-by-one on the readout. Note: never drop or throw the Horiba U-10 probe into the water; it can be damaged beyond repair by unnecessary rough handling.

8. After either collecting parameter measurements, discard the water in the Horiba U-10 sample/calibration container back into the river. Immediately clean the Horiba U-10 sample/calibration container per SOP-7: Decontamination of Water Sampling Equipment. Be sure to rinse the probes thoroughly with water.

9. Fill the Horiba U-10 sample/calibration beaker with deionized or equivalent water and fit the probe over it.

10. All data collected from the Horiba U-10 are recorded in the field computer. The data is stored in the instrument, and transferred periodically during the survey. Upon completion of sampling at one location, all ancillary data (*e.g.* date, time, position, etc.) is entered into the field application. The field application prompts the user for the required information and also automatically uploads daily weather and tidal conditions from the NOAA website. Blank field log sheets to record information manually will be provided in case difficulties with data entry into the field computer are encountered.

11. Water quality data should be reviewed as often as is practical to assure results are within expected ranges and the instrument is operating properly. Graphical plots or spreadsheet average/minimum/maximum review are suitable methods. If data is suspect, the discrepancy is noted in the field application, and the meter should be re-calibrated as soon as practible.

12. After a successful profile, enter prompted information into the field application:
    - Date
    - Time of water column profile
    - Actual coordinates of the sample location
    - Water depth (ft)
    - Instrument Serial Number
    - Sensor data collected
    - Observations

13. At the end of each day, an electronic copy (disk) of the field application that includes the information recorded for each profile collected that day will be created as a back up of that day's project information. A copy of the signed field log form will be maintained by the field team leader.

IV. Reference

Horiba U-10 Water Quality Checker Instruction Manual, Horiba Ltd., November 1991.

Title: Management and Disposal of Investigation Derived Waste

I. Introduction

This procedure describes the methods used to manage, store, and dispose of investigation derived waste (IDW) produced during environmental sampling for the Lower Passaic River Restoration Project. The procedures specifically address sediments, soils, water, solvents, and Personal Protective Equipment (PPE) waste generated from collection of sediment, soil and water samples and equipment decontamination.

This SOP does not address radioactive decontamination, PPE for radioactive waste, or disposal of radioactive contaminated waste material.

II. Definitions

PSO: Project Safety Officer
IDW: Investigation derived waste
PPE: Personal Protective Equipment

III. Equipment and Supplies

The purchase, maintenance, and use of the supplies and equipment listed below are the responsibility of the Project Safety Officer (PSO) and Processing Facility Manager.

The following equipment and supplies will be used to collect and dispose of investigation derived waste:

1. Waste Storage and Disposal Containers

   A. 30- or 55-gallon drums for solid and liquid wastes, including 30 gallon plastic drums for solids, and sealed top drums with screw-plug openings for liquids. As for liquid storage, steel (6D) drums will be used in the storage of solvent waste. For aqueous organic and acid waste, polylined (17E) drums will be used for storage.

2. Transferring Equipment

    A. Plastic safety funnels with brass or plastic screens and vents.
    B. Hand pump/siphon with Teflon or tygon tubing.
    C. Tools: screwdriver, drum plug wrench, and brass pliers.
    D. Drum dolly.

3. PPE

    A. Disposable Tyvex coveralls and/or lab coats.
    B. Disposable plastic gloves (nitrile, butyl rubber, or Viton).
    C. Respirator and cartridges (consult PSO to determine PPE requirements).
    D. Shoe covers (rubber or Tyvek).

4. Spill Cleanup Equipment and Supplies

    A. Spill absorbent (Vermiculite or Speedidry™).
    B. Broom, foxtail and dustpan.
    C. Shovel.
    D. Paper towels.
    E. 85-gallon overpack drum.
    F. Manual drum pump (same as pump in 'Item 2. Transferring Equipment').

5. Labels and Logs: A supply of labels and log sheets that are referred to in this SOP are to be kept on site in an easily accessible location, described in the Work Plan. Additional logs will be obtained from the Processing Facility Manager.

6. Digital camera to document IDW management.

IV. Guidelines

The following procedures will be used to store, manage, and transport IDW:

1. Waste Disposal: IDW is held in the appropriate designated storage area until approval for disposal is granted. After the PSO and Processing Facility Manager receive documentation on the level of contamination in the waste, they will assist the Project Manager in deciding whether the waste is suitable for disposal in a landfill, or must be discarded in a hazardous waste stream.

2. Solid Waste
   A. Solid waste is to be transferred into an air-tight, 30 gallon open top drum.
   B. The lid is to be removed from the collection container and the contents placed into the storage drum.
   C. Once the transfer has been completed, the lid and sealing ring are to be replaced on the storage drum.
   D. The transfer will be recorded on the waste transfer log, and this log will be placed in a location described in the Work Plan for reference.

3. Liquid Waste

   A. All solvents used for decontamination must be captured and disposed of in appropriate, labeled, aqueous waste containers. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream. Care must be taken not to mix substances that will react with each other. If there is any question concerning compatibility, the PSO or Project Manager should be contacted prior to taking action. A record of the type, relative amount, and hazard associated with each substance added must be kept on the hazardous waste log. This log must be attached to the satellite container. Waste may be temporarily stored, if properly labeled, prior to satellite container introduction. The waste contents in these temporary storage containers must be introduced into an approved satellite container by the end of every working day.

B. Staff performing decontamination procedures need to wear appropriate PPE, gloves (*e.g.*, nitrile) and eye protection. Care must be taken in cleaning not to allow contact of cleaning solutions with clothing as much as possible. If circumstances dictate contact will occur (*e.g.*, high pressure washing, splashing, high wind), waterproof outer clothing must be worn (*e.g.*, foul weather gear or rain gear).

C. Liquid waste is to be transferred into an air-tight, 55-gallon, screw-cap drum. When a new drum is started, the larger cap is unscrewed with the drum plug wrench. The safety vent is screwed in and the cap tightened by hand.

4. PPE

A. PPE are to be transferred into air-tight, 30 gallon open top drums.

B. The lid is to be removed from the collection container and the contents placed into the storage drum.

C. Once the transfer has been completed, the lid and sealing ring will be replaced on the storage drum.

5. Project Safety Officer: Along with the Processing Facility Manager, the PSO is responsible for overseeing IDW collection and management and arranging for IDW to be disposed of off site in accordance with local, state, and federal Regulations. The responsibilities of the PSO and Processing Facility Manager include:

A. Packaging and labeling of containers.

B. Arranging for waste removal.

C. Maintaining manifest records and tracking the manifest until its signed and returned.

D. Conducting weekly inspections of the waste area.

E. Ensuring that the proper waste-handling materials and personal protective equipment are available and adequate (*e.g.*, gloves, coveralls, goggles, respirators and cartridges, boots, funnels, pumps).

F. Maintaining emergency spill response equipment.

Prepared by: Stephanie Cedro
Reviewed by: John Logigian

Title: Secchi Disk Depth (Transparency) Measurement

I. Introduction

This procedure describes the equipment and methods to be used to collect Secchi Disk depth (transparency) measurements for the Lower Passaic River Restoration Project. Transparency can be measured quickly and easily, but is sensitive to light intensity, reflection, and turbidity.

II. Equipment and Supplies

The following equipment will be needed to collect transparency measurements using the Secchi Disk:

1. Secchi Disk: named after Pietro Secchi, who first used it in 1865 to measure the transparency of the Mediterranean Sea. The disk is made of rigid plastic or metal, but the details of its design are variable. It may be 20 to 30 cm or even larger in diameter and is usually painted white. Alternatively, it may be painted with black and white quadrants. The disk is suspended from a calibrated line, or attached to a calibrated rod. Earlier models, pictured below, have an attached weight. Modern models need no weights and are typically made of acrylic with a center hook eye and rope.

   A 200 mm (7-7/8") plastic Secchi Disk will be used. It will have four quadrants, two white and two black. The disk will be attached via a hook eye to 20 meters of 1/8" diameter line on a Styrofoam form that will float if dropped in the water.

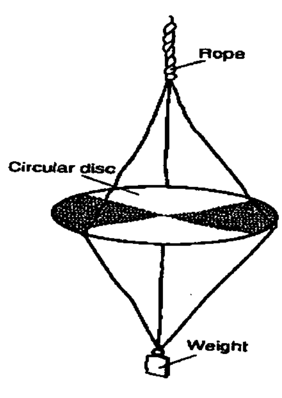


Figure 1: Secchi Disk

2. Boat or waders: to get to the measurement location.

3. Personnel protective equipment (PPE): none (However, PFD required for boat or when wading. HASP PPE required for measurements conducted in contaminated waters.)

4. Miscellaneous Supplies – Garbage bags, decontamination supplies (Paper towels and Alconox), measuring tape, field book, field application equipment, and GPS.

III. Guidelines

1. Try not to not make measurements early in the morning or late in the afternoon because sun glare may distort observations. Wear polarized sunglass if this reduces the surface reflection and improves visibility of the disk.

2. Lower the Secchi Disk through a shaded area of water surface, where possible.

3. As the disk is lowered, note the depth at which it just disappears from view.

4. Lower the disk a little further, then raise it and note the depth at which it reappears.

5. Record the average of the two depth readings as the Secchi Disk transparency. The report must also state the diameter of the disk (200 mm) and the four quadrant pattern on the upper surface of the disk.

IV. References

Lind, O.T. 1979. Handbook of common methods in Limnology. C.V. Mosby Co. Saint Louis.190 pp.

Water Quality Monitoring - A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes. © 1996 UNEP/WHO. (http://www.who.int/docstore/water_sanitation_health/wqmonitor/ch08.htm#b2-6.2%20Transparency accessed 7-27-05).

Place Holder for SOP 24 Eckman Dredge

Attachment 2
Hydrodynamic and Sediment Transport Sampling Plan for 2004-2005; July 2004
and Site Selection Rationale Memorandum; May 2005

Lower Passaic River Restoration Project

Hydrodynamic and Sediment Transport Sampling Plan for 2004-2005

April 2005

Malcolm Pirnie, Inc.

Developed in association with

HydroQual Inc.
Battelle

Section 1
Introduction

1.1 Purpose

The purpose of this plan is to describe the 2004-2005 hydrodynamic sampling that will be conducted in the Lower Passaic River and provide guidance for the proposed field work through detailed descriptions of the sampling and data gathering methods. Initially, hydrodynamic sampling that focuses on the Harrison Reach was proposed by Rutgers University and the U.S. Geological Survey (USGS) to aid the N.J. Department of Transportation - Office of Maritime Research (NJDOT-OMR) in the implementation of a pilot dredge study planned by NJDOT-OMR for 2005. According to the Rutgers and USGS 2004 proposal, Characterizing the circulation and dispersive nature of the Passaic River and its dependence on river discharge and tidal range: elucidation of major processes that determine the impact of the proposed Passaic River dredging project, the purpose of NJDOT-OMR's investigation is to "characterize the aspects of the circulation and dispersive nature of the Passaic and describe how these processes change with tidal range and river discharge."

This same type of information is also needed by the Superfund project team, led by the U.S. Environmental Protection Agency (USEPA) Region 2, for the entire 17-mile tidal stretch of the Lower Passaic River. Therefore, two studies that complement each other, one through NJDOT-OMR and the other through the Superfund project team are proposed. This document discusses the data to be collected through both studies and provides details on the Superfund sampling.

1.2 Objective

One of the primary objectives for the Lower Passaic River Remedial Investigation and Feasibility Study (RI/FS) is to develop and apply a scientifically-based model that specifically incorporates hydrodynamic transport, sediment transport, contaminant fate and transport and bioaccumulation processes. This model will be used as a tool for understanding historical and current sources and sinks of organic and inorganic contaminants in the Passaic River and adjacent water bodies through mass balance analyses, as well as provide the basis for an engineering evaluation of potential remedial scenarios. To support this objective, it is necessary to monitor the river under both long-term and specific short-term (*e.g.*, during high-flow storm events) conditions to provide the data for model calibration and for comparison with the model predictions so that model performance can be made representative of the actual system conditions. This will allow the model to be used to simulate alternative scenarios within the system under both existing and hypothetical future conditions.

Large modeling projects require extensive parameter estimation as well as extension and extrapolation of the available data. This hydrodynamic and sediment transport monitoring program is intended to collect key data required to support the modeling effort. While some of the data collected will provide information on the long-term time series of hydrodynamic and suspended sediment concentrations, other data, like those obtained from experimental and field efforts on sediments deposition and erosion characteristics, will be used primarily for calibration of sediment parameters. In general, the greater the number of monitored locations and the frequency of data collection, the more closely the model can be made to replicate actual measured conditions.

To meet these objectives, the proposed hydrodynamic sampling program will:

- Objective 1 - Provide a baseline data set within the estuary for calibrating and assessing the skill of the hydrodynamic components of the proposed Lower Passaic River Model.
- Objective 2 - Determine sediment erosion and settling/flocculation to characterize model parameters.
- Objective 3 - Provide baseline data for characterizing the discharge and loads of suspended solids over the Dundee Dam, a boundary condition for the Lower Passaic River Model.

- Objective 4 - Provide current bathymetric survey data to further characterize sediment mobility, aid in future sediment sampling and risk assessment investigation and provide a dataset for comparison to previous surveys.
- Objective 5 - Determine the processes controlling the short-term fate and transport of particles[1] within the estuary, especially at the estuarine turbidity maximum (ETM).
- Objective 6 - Determine the variability in total suspended solids (TSS), particulate organic carbon (POC), and grain size, under varying tidal conditions, upstream river discharge, and stratification.

1.3 Sampling Scope

1.3.1 NJDOT-OMR Dredge Pilot Hydrodynamic Study

The **NJDOT-OMR** Dredge Pilot Hydrodynamic Study proposed by Robert Chant, Rutgers University and Tim Wilson, USGS, which will mainly cover areas down-estuary of the Harrison Reach (approximately river mile (RM) 4.4), will meet their study objectives through the following work:

- Installation of long-term moorings in the Passaic River and shipboard surveys to characterize the salinity and sediment structure of the River over a range of river flow conditions. The fixed stations are expected to remain in place for a year from approximately June 2004 through June 2005. The discrete sample monitoring is expected to occur from June 2004 through June 2005.
- Detailed tidal cycle surveys in the Harrison Reach to characterize the spatial structure of currents, total suspended sediment, stratification and bottom shear stress in the vicinity of the pilot dredging study
- A dye study to quantify the dispersive nature of material released into the water column in the Harrison Reach of the river.

---

[1] Several of the important contaminants of potential concern (COPCs) in the Lower Passaic River (*e.g.*, dioxin, polychlorinated biphenyls (PCBs), mercury) are associated with particles. Various processes affect the total suspended sediment (TSS) concentrations in estuaries in time scales that vary from seconds to

1.3.2 Superfund Study

The Superfund monitoring program will cover all five reaches that encompass the 17-mile tidal portion of the Lower Passaic River and will not duplicate the sampling conducted for NJDOT-OMR. The Superfund team's surveys and discrete sampling are expected to start in November 2004 and, to the extent possible, the NJDOT-OMR and Malcolm Pirnie sampling efforts will complement each other. The activities that will be implemented to achieve the Superfund program objectives are listed in Section 2 below.

years. These processes include, but are not limited to, turbulence, tidal circulation, wind waves, freshwater discharge, and climate.

Section 2
Detailed Sampling Tasks and Procedures

2.1 Sampling Activities

During the Superfund hydrodynamic and sediment transport monitoring program, the following sampling activities will be conducted:

- Moored instrumentation will be installed at fixed stations within each reach of the river to monitor turbidity, temperature, velocity, depth, conductivity. This activity will be required for Objectives 1 and 6.
- Shipboard and cross-sectional surveys will be conducted to monitor turbidity, temperature, velocity, depth, and conductivity, as well as to collect water samples for TSS, VSS, POC, beryllium-7 (Be-7) and thorium-234 (Th-234) analyses at different river flows, precipitation events and tidal ranges. This activity will be required for Objectives 1, 5 and 6. Note that studies in estuarine systems (Ciffroy et al., 2003; Feng et al. 1999a, 1999b) have suggested that naturally-occurring radionuclides that associate strongly with particles (*e.g.* Be-7 and Th-234) are useful tracers of the processes affecting particle dynamics within estuaries. A description of the use of these naturally-occurring radionuclides as particle tracers can be found in Appendix A.
- A gauging station will be installed above the Dundee Dam to monitor river discharge and collect samples for water quality analyses including: TSS/volatile suspended solid (VSS), POC, grain size, Be-7 and Th-234. This activity will be required for Objectives 3 and 5.
- Surface sediment samples will be collected for Be-7 and Th-234 analyses. This activity will be required for Objective 5.
- Special sediment characterization studies will be performed to characterize erosion and settling/flocculation. This activity will be required for Objective 2.
- A bathymetric survey will be conducted for the entire 17-mile stretch. This activity will be required for Objective 4.

A detailed description of the field work and sampling activities are presented below. The Standard Operating Procedures (SOPs) that are applicable to the field work are provided with the other project SOPs as an Attachment to FSP Volume 1. Note that the grain size analysis mentioned in this monitoring plan refers to a rapid particle classification as cohesive (less than 62.5 μm) and non-cohesive (greater than 62.5 μm) fractions. The number of samples and analyses for each activity described below are summarized in Table 1.

2.2 Surface Water Monitoring At Moored Stations

The continuous monitoring using moored instrumentation installed at fixed stations within each reach of the Lower Passaic River, which will result in fixed-point time series of a variety of model calibration and evaluation data, including current velocities and directions, salinity, temperature and suspended sediment concentrations will be required to meet parts of objectives 1 and 6 given in Section 1.2. The activities of **NJDOT-OMR** and the Superfund team needed to achieve to conduct surface water monitoring at moored stations are summarized below.

2.2.1 NJDOT-OMR Activities

Based on the Rutgers/USGS final proposal (2004), **NJDOT-OMR** will install an array of six moorings (Figure 1). Two of these moorings will be deployed in the Harrison reach, one located in the deep channel, and the second on the shoaling southern flank. Each of these two moorings will contain an Acoustic Doppler Current Profiler (ADCP), surface and bottom conductivity/temperature (CT) sensors, and a bottom optical backscatter sensor (OBS). The other four moorings will contain surface- and bottom-mounted CT sensors. In addition, the farthest upstream and downstream moorings will each contain OBS sensors and paroscientific pressure sensors that are accurate to a few millimeters. The pressure sensors will provide estimates of along-river pressure gradients that, together with time-series of velocity measurements from the central array, can be used to provide bulk estimates of bottom shear stress, which will be useful for modeling efforts. The ADCPs will obtain estimates of current velocity in 25 cm bins at a temporal resolution of 15-30 minutes. The ADCP also records the acoustic backscatter that can be calibrated against the measured suspended sediment from bottle samples to provide high-resolution estimates of total suspended sediment.

NJDOT-OMR proposes two mooring deployments. The first is expected to run from late summer to late fall to capture both circulation during the low flow summer conditions and the increased river discharge rates that occur in the fall. The second deployment will cover the late winter/early spring to catch the spring freshet. In conjunction with these moorings, NJDOT-OMR plans to collect a single vertical profile of suspended sediment, total dissolved salt, conductivity, and water density in the vicinity of each mooring - once when the moorings are deployed and again when retrieved. As per the request of the Superfund team, the NJDOT-OMR TSS samples will also be analyzed for VSS. Up to 10 samples will be collected at 1 meter intervals. The data provided by these samples will document the calibration of the instrumentation. The maximum total number of samples collected for the mooring work is estimated at 240.

2.2.2 Superfund Team Activities

The **NJDOT-OMR** mooring installations end in the Newark Reach. Since information on hydrodynamics and sediment transport in the entire 17-mile tidal system is needed, the Superfund team will install 3 moorings in the following up-estuary areas: 1) one station between the Dundee Dam and the Third River; 2) one station between the Third River and the Second River, and; 3) one station in the Kearny Reach (see Figure 1). The Superfund team also expects that a fourth monitoring station will be installed in Newark Bay by Tierra Solutions, Inc. (TSI). The Superfund mooring stations will contain: (i) a surface and a bottom OBS unit that monitors turbidity (ii) surface and bottom CT sensors, with the surface sensors approximately 1 meter below water surface and the bottom sensors approximately 1 meter above the sediment (Kearny Reach and Newark Bay stations only); and (iii) an ADCP that monitors the water column current profile for all stations. During the deployment and retrieval of these moorings, the Superfund team will collect a single vertical profile of 10 1-Liter bottle samples at approximately 1 meter intervals, in the vicinity of each mooring. The total expected number of samples is 60 and each will be analyzed for TSS, VSS, and conductivity.

2.3 Discrete Surface Water Sampling During CTD Shipboard Surveys

Data will be collected during shipboard surveys to supplement the data obtained from the moorings, as well as to:

- Characterize the strength of the two-layer flow in the tidal Passaic River
- Delineate the location of the salt wedge and the stratification as a function of river flow
- Identify the physical and chemical processes affecting the short-term particle transport and deposition
- Provide data to test the skill of the planned hydrodynamic model simulation of the Lower Passaic River

The activities of NJDOT-OMR and the Superfund team during the CTD surveys are summarized below.

2.3.1 NJDOT-OMR Activities

From June 2004 through June 2005, NJDOT-OMR will run approximately 12 CTD surveys beginning in Newark Bay and ending either at the head of salt or as far as the river is navigable. NJDOT-OMR will attempt to procure a low-clearance vessel so that, combined with operating at low tide, navigation will be possible in the upper reaches of the Lower River where bridge clearance can be less than 8 feet. They will select dates that cover a range of river discharges with emphasis on high-discharge conditions. Salinity will be measured with an OS-200 CTD probe that obtains estimates of salinity, temperature and pressure at a rate of 6 Hz. CTD casts will be made at approximately 1-km intervals in the river. The CTD will be mated with an OBS to characterize the suspended sediment concentration. Within each CTD section, approximately 10 1-liter bottle samples will be collected to calibrate the OBS sensor. In addition, NJDOT-OMR will sample the river water to determine the suspended sediment and salinity distribution in detail. At approximately 1-km intervals, one vertical profile will be sampled at four depths to characterize the particulate and salt distribution across the river. Samples will be collected at 1 meter below the surface, 1 meter above the bottom, and at 2 locations through the mid-range depth. The mid-river vertical profile will be made in the vicinity of the CTD tow, allowing the data to be used for instrument calibration as well as river characterization. Samples will be measured for suspended sediment, total dissolved salts, and conductivity. The total number of sampling locations for this objective is 960. A subsection of these samples will also be measured for density in the USGS District Laboratory.

The Superfund team has requested that NJDOT-OMR collect water samples during the CTD surveys for POC and grain size analysis. It is assumed that POC samples will be collected during the first two CTD surveys (approximately 50 samples), while grain size will be collected under different discharge conditions during any two CTD surveys (approximately 40 samples). The POC and grain size samples will be analyzed by the Superfund team. The TSS samples collected by NJDOT-OMR will also be analyzed for VSS by the USEPA Edison Lab.

2.3.2 Superfund Team Activities

The Superfund team will be involved in three separate activities including: (i) extending the CTD surveys up-estuary of the NJDOT-OMR CTD survey, (ii) collecting suspended particulates samples for radionuclides analysis along the longitudinal axis of the estuary and, (iii) collecting suspended particulate samples for radionuclides analysis at the ETM.

It is assumed that that the NJDOT-OMR CTD survey will likely end at approximately River Mile (RM) 12 because of a low bridge in this vicinity. To provide complete characterization of the 17-mile Lower River, the Superfund team will complement the NJDOT-OMR CTD surveys by conducting approximately 10 CTD surveys and collecting vertical profiles of water samples at approximately 1-mile intervals starting at Ackerman

Bridge (approximately RM 16) and ending at RM 12. The Superfund team will collect water samples at 1 meter below the surface and 1 meter above the bottom at four stations per cross-section for TSS/VSS and conductivity analyses (80 samples). Approximately 16 water samples will be collected for grain size analysis.

During three of the CTD surveys, the Superfund team will collect large suspended particle samples in the vicinity of each mooring for radionuclide (Be-7 and Th-234) analysis. The samples will be collected by filtering large-volume water samples (from 200 to 1500 L, depending on location) using protocols described in Feng *et al.* (1999a) and summarized in Appendix B. Samples will be collected at two depth intervals: surface (approximately 1 meter below surface) and near-bottom (approximately 1 meter above bottom) using a boat-powered pumping system. The pumped water will be filtered to obtain approximately 5 to 15 grams of suspended sediment for analysis. Since this process may require up to two hours, the Superfund team will also collect separate aliquots of 500-ml water samples at the beginning and at the end of pumping at each station for TSS and conductivity analysis. These 500-mL samples will provide information on the changes in the water column properties during the pumping process. The analysis of this data will be in accordance with Feng *at al.* (1999b). The total number of suspended particulate samples for radionuclide analyses is expected to be 48; 96 water samples will be collected for TSS and conductivity analyses.

In an effort to understand the dynamics and sources of particles to the ETM, the Superfund team will also set up a cross-section of three stations in the ETM and collect large-volume water samples for analysis of suspended particle radionuclides (Be-7 and Th-234). Sampling will be conducted over the course of several tidal cycles in the ETM, with the three stations being sampled on three successive days (1 station per day). The suspended particles will be collected approximately 6 to 8 times per day, at two depth intervals: surface (approximately 1 meter below the surface) and near bottom (approximately 1 meter above the bottom). Protocols for collecting these samples are provided in Appendix B. The analysis of this data will be performed in accordance with

Feng *at al.* (1999b). The maximum number of samples to be collected for radionuclide analysis is 48; 96 water samples will be collected for TSS and conductivity.

2.4 Discrete Surface Water Sampling During Cross-Section Ship-Track Surveys

Most of the activities above focus on sampling along the main channel, with little consideration to cross-sectional variability. Cross-sectional surveys and sampling are important as they provide information on cross-channel circulation, especially along river bends. They also provide water quality cross-sectional distribution data that will be useful in assessing the model's capability to simulate observed vertical and cross-channel shears in the flow. Assessment of the model's capability to adequately simulate vertical and cross-channel shears in flow is critical since vertical and horizontal shears drive dispersion in a tidal riverine system (Rutgers/USGS Proposal, 2004; Taylor, 1951; Wilson and Okubo, 1975; Smith, 1976; Fischer, 1978). Cross-sectional ship track survey activities by NJDOT-OMR and the Superfund team are outlined below.

2.4.1 NJDOT-OMR Activities

NJDOT-OMR proposes a total of four days of shipboard surveys to characterize the tidal currents. This field work will occur in the late summer/early fall of 2004, with two of the shipboard surveys conducted during neap tide conditions and two surveys conducted during spring tide conditions. NJDOT-OMR will complete the sections shown in Figure 2 approximately once every hour over an 8-12 hour period. By fitting tidal period harmonics to time series of currents observed at grids along this track NJDOT-OMR will generate a detailed model of tidal currents in this reach during neap tide and spring tide conditions. NJDOT-OMR anticipates spending approximately 3 minutes surveying each 100-meter section to generate currents with resolution of approximately 10 meters in the cross-stream direction and 25-cm in the vertical. This would provide a more spatially detailed view of the tidal and subtidal motion in the Harrison Reach than provided by the moorings. In conjunction with these cross-sectional tidal current surveys NJDOT-OMR proposes to also characterize the cross sectional distribution of suspended sediment and dissolved salt in this reach of the river. During the shipboard surveys, samples will be collected at each cross section in a grid of three verticals at three depths (1 meter below surface, one meter above bottom, and mid section, 9 samples total per cross section). These samples will be analyzed for suspended sediment, dissolved salt, and conductivity. Approximately 470 samples will be collected.

During one of the shipboard surveys, the Superfund team has requested that NJDOT-OMR collect water samples for grain size (18 samples) along one cross-section in the Point No Point Reach and one cross-section along the Harrison Reach. Because the NJDOT-OMR TSS analysis will be done by the EPA Edison Lab, the Superfund Team has also requested that the TSS samples be analyzed for VSS.

2.4.2 Superfund Team Activities

Due to the limited extent of the NJDOT-OMR cross-section survey, the Superfund team will expand the cross-section surveys to areas up-estuary of the Harrison Reach. On two days during neap tides and two days during spring tides the Superfund team will conduct ship board surveys starting from approximately RM 5 up to the Ackerman Bridge, monitoring currents using an ADCP and collecting water samples along river sections spaced approximately 1 mile apart (~ 12 cross-sections). At each cross-section, the Superfund team will: (i) use an ADCP to generate currents with resolution of approximately 10 meters in the cross-stream direction and 25-cm in the vertical, and (ii) collect water on a grid of three verticals at two depths (1 meter below surface and 1 meter above bottom) for TSS/VSS, and conductivity analysis (264 samples).

During one of the shipboard surveys, the Superfund team will collect additional water samples for grain size analysis along one cross-section in the Newark Reach, one cross-section in the Kearny Reach and two cross-sections in the Upstream Reach. Each cross-section will consist of a grid of three verticals at two depths (1 meter below surface and 1 meter above bottom) for a total 24 samples.

2.5 Monitoring Gauge and Water Quality at Dundee Dam

It is important to accurately quantify the flux of contaminants over Dundee Dam because Dundee Dam is a boundary condition for the proposed Superfund hydrodynamic and sediment transport model for Passaic River. The Superfund team and the EPA will work with the USGS to set up a gauging station just above the dam, to quantify the discharge over the dam. In addition, this station will be used to collect surface water samples, under varying flow conditions, for TSS, VSS, grain size and POC analyses. The details of this monitoring are yet to be finalized.

2.6 Surface Sediment Sampling

Collection of surficial sediment samples will be conducted by the Superfund Team only. To compare the radionuclide activities in the water column relative to that in surface sediments, surface sediments samples (0 to 0.5 cm) will be collected using a box corer by the Superfund field team in the vicinity of the moorings where water samples are collected for the radionuclide analysis (approximately 9 samples), as well as along the cross section of the ETM (approximately 3 samples). The sediments will be analyzed for Be-7 and Th-234 along with grain size.

2.7 Special Sediment Studies

The sediment transport model that will be developed for the site (Refer to Section 7) will include sediment erosion, sediment transport, and deposition of both cohesive and non-cohesive sediments. Calibration of these processes requires that data be collected to determine site specific values of parameters in the formulations describing these processes. The primary site characteristics that affect sediment stability are the shear stress at the river bottom under varying conditions and the physical properties of the upper sediment layers, which can be affected by bioturbation.

Sediment deposits can change significantly in spatial extent (both horizontally and vertically) and can be resuspended and redeposited by storms and other river hydraulic altering events (e.g., dredging). For the long-term prediction of both sediment and contaminant transport, one of the most significant processes to understand and quantify is sediment erosion. These rates can change by orders of magnitude, not only as a function of the applied shear stress due to waves and currents but also as a function of horizontal location and depth in the sediment. In this hydrodynamic and sediment transport special sediment studies will be conducted for sediment erosion, and sediment settling/flocculation as descried below.

2.7.1 Sediment Erosion

Cohesive sediment erosion is highly site-specific, requiring site specific measurements to parameterize model formulation for erosion. Erosion rates depend on the relative magnitude of the shear strength of the sediment and the shear stress exerted on the sediment surface. The shear strength can be affected by the following parameters: bulk density, particle size, mineralogy, organic content, salinity of the pore water, amount of gas, oxidation or other chemical reactions, and consolidation time. Erosion measurements involve specialized devices, and two devices will be used to characterize the erodability of sediments in Passaic River, including the Gust Microcosm to understand erosion at the surface and SedFlume to understand erosion with depth. The erodability experiments will be conducted in the field on relatively undisturbed cores collected from at least 15 locations in the river. Sediment cores will be collected using box corers for these experiments. After each core is collected, a Density Profiler (Gotthard, 1998) will be used to give a non-destructive and high resolution measurement of bulk density as a function of depth in the core. In addition, sediment samples will be obtained for Pb-210 analysis over 15 depths in the top 40-50 cm of the sediment cores. During the erosion test, small amounts of sediment will be removed at different depths in the core and used to determine the other bulk properties of the sediment sample including water content, grain size (using a Malvern Mastersizer) and organic content (Roberts et al., 1998).

2.7.1.1 Gust Microcosm

For the surface sediments, Gust Microcosm field experiments will be conducted to test for changes in surficial sediment erodibility over the range of 0-0.4 Pa applied shear stress. These erosion tests and protocols, which involve increasing shear stress through approximately 8 levels, with each level of constant stress lasting approximately 20 minutes, are described in detail in Sanford and Maa (2001). This experiment will only be conducted on a subset of samples.

2.7.1.2 SedFlume

SedFlume experiments will be conducted on sediment cores to determine erosion rates as a function of depth and shear stress. This flume can measure erosion rates of sediments at high shear stresses (up to stresses on the order of 20 N/m2) and with depth (down to a meter or more). Therefore, Sedflume measures in-situ sediment erosion at shear stresses ranging from normal flow to flood conditions and with depth below the sediment/water interface. Protocols for conducting SedFlume experiments are described in McNeil, et al. (1996) and the SedFlume theory is summarized in Appendix B.

2.7.2 Sediment Settling/Flocculation

Settling is the downward movement of sediments through the water column due to gravity. In the case of cohesive sediments, flocs are formed by the process of flocculation, which is the result of simultaneously occurring aggregation and floc break-up processes. A combination of in-situ techniques are being considered to determine settling velocities of particles in the Passaic River. First option is to conduct Modified Valeport Settling Tube experiments (Owen-type bottom withdrawal settling tube) on water column TSS samples to determine settling velocities. This instrument consists of a long slender tube, which is lowered in the water in horizontal position to collect a water column sample. The protocols for determining the settling velocity using this tube are described in Sanford, et al. (2001). The second in-situ method includes the use of a laser in situ scattering and transmissometry (LISST) instrument system in combination with an optical backscatter sensor (OBS). These devices have been used to determine concentration and fall velocities of estuarine particle populations in the lower Chesapeake Bay, and the details are described in Fugate and Friedrichs (2002). The third method of in-situ measurement involves the use of a video settling tube that optically monitors the settling flocs in a vertical tube. This system is generally used in the Lagrangian mode, and suspended flocs are captured in a so-called capture/stilling chamber. Digital image analysis techniques have been developed to establish floc size and settling velocity distribution, and sometimes floc structure from the video recordings and the protocols are described in Eisma, (1996) and Dyer et al. (1996).

2.8 Bathymetric Survey of River Bottom

The Superfund Team will conduct a bathymetric survey of the entire 17-mile stretch of the study area. This data will provide addition information to the modelers on sediment stability, and can be compared to historical surveys done at this site. The bathymetric survey will be conducted using a survey vessel and an Innerspace 455, 200 KHz single-beam survey grade fathometer for this work. The bathymetry shall be referenced to NGVD 29. The survey will be conducted using 100-foot lanes and its accuracy will be greater than or equal to +/- 0.5 feet. Approximately eight vertical controls will be established over the length of the river to complete the survey.

There are 20 bridges that cross the Passaic over the 17 mile survey area. There will be GPS multi-path errors, possibly at every bridge. As much as 500-1000 feet of coverage could be lost on each side of these bridges. This will be corrected by the use of Total Station. Following the completion of the survey work, the data will be reviewed and a determination will be made about multi-path errors around each bridge. A secondary survey will then be conducted using a Total Station setup to recollect data in those areas.

The survey team will use a Trimble real time kinematic (RTK) GPS capable of repeatable centimeter accuracy for navigation control and positioning while conducting the survey. Positioning data will be collected in NJ State Plan NAD 83 and sent to a computer running Coastal Oceanographics Hypack Max software for survey control, ship positioning, and data acquisition. Positioning data will be collected every second while conducting surveys. Survey lines will run perpendicular to the riverbank.

The Superfund team will coordinate this effort with a USACE bathymetric survey on the navigable portion of the river that is expected to occur in summer 2004.

Table 1. Summary of Number of Samples and Analysis per Sampling Activity for Superfund Team and NJDOT-OMR Team

Activity	Superfund Team		NJDOT-OMR Team	
	Total # Samples	Analysis (# Samples)	Total # Samples	Analysis (# Samples)
Moorings	60	TSS,VSS, Conductivity (60 samples)	240	TSS,VSS[3], Conductivity, water density
CTD Surveys	396	TSS,VSS[2], Conductivity (272 samples)	1010	TSS,VSS[3], Conductivity (960 samples)
		Grain Size (16 samples)		[1]POC (50 samples)
		Be-7 & Th-243 (108 samples)		[1]Grain Size (40 samples)
Shipboard Surveys	288	TSS,VSS, conductivity (264 samples)	488	TSS,VSS[3], conductivity (470 samples)
		Grain Size (24 samples)		[1]Grain Size (18 samples)
Surface Sediment	12	Be-7 & Th-243, Grain size (12 samples)		

[1] Samples collected by NJDOT-OMR for Superfund Team
[2] VSS analysis performed on 80 of the 272 samples only
[3] VSS analysis of water samples will be done as per Superfund Team request.

References:

Ciffroy, P., J.L. Reyss, F. Siclet. 2003. Determination of the residence time of suspended particles in the turbidity maximum of the Loire Estuary by ^{7}Be analysis, Estuarine Coastal and Shelf Science. 57: 553-568.

Dyer A.R., *et al.* 1996. A comparison of in situ techniques for estuarine floc settling velocity measurements. Journal of Sea Research 36 (1/2): 15-29.

Eisma D. *et al.* 1996. Intercomparison of in situ suspended matter (floc) size measurements. Journal of Sea Research 36 (1/2): 3-14.

Feng, H., J.K. Cochran, J. Hirschberg. 1999a. ^{234}Th and ^{7}Be as tracers for the transport and dynamics of suspended particles in a partially mixed estuary. Geochimica et Cosmochimica Acta. 63(17): 2487-2505.

Feng, H., J.K. Cochran, J. Hirschberg. 1999b. ^{234}Th and ^{7}Be as tracers for the sources of particles to the turbidity maximum to the Hudson River estuary. Estuarine Coastal and Shelf Science. 49:629-645.

Fischer, H.B. 1973. Longitudinal dispersion and turbulent mixing in open-channel flow. Annu. Rev. Fluid Mech. 5:98-78.

Fugate, D.C, C.T. Friedrichs. 2002. Determining concentration and fall velocity of estuarine particle populations using ADV, OBS and LISST. Continental Shelf Research 22: 1867-1886.

Gotthard, D., 1998. Three-Dimensional, Non-Destructive Measurements of Sediment Bulk Density Using Gamma Attenuation. Report, Department of Mechanical and Environmental Engineering, University of California, Santa Barbara, CA 93106.

McNeil, J., C. Taylor, W. Lick. 1996. Measurements of the erosion of undisturbed bottom sediments with depth. J. Hydraul. Eng. – ASCE, 122(6), 316-324.

Roberts, J., R. Jepsen, D. Gottard, W. Lick. 1998. Effects of particle size and bulk density on erosion of quartz particles. J. Hydraul. Eng. – ASCE, 124(12), 1261-1267.

Sanford, L.P., S.E. Suttles, J.P. Halka. 2001. Reconsidering the physics of the Chesapeake Bay Estuarine Turbidity Maximum. Estuaries, 24(5): 655-669.

Sanford, L.P. and J.P.-Y. Maa. 2001. A unified erosion formulation for fine sediments. Marine Geology, 179(1-2): 9-23.

Smith, R., 1976. Longitudinal dispersion of a buoyant contaminant in a shallow channel. J. Fluid Mech 78 (Pt. 4) 677-688.

Taylor, G.I., 1954. The dispersion of matter in turbulent flow through a pipe. Proc. London Math. Soc. Ser A, 223:446-468.

Wilson, R.E., A. Okubo, 1978. Longitudinal dispersion in a partially mixed estuary. J. Mar. Res. 36: 427-447.

APPENDIX A

Naturally-Occurring Radionuclides as Particle Tracers

Naturally-Occurring Radionuclides as Particle Tracers

One of the objectives of the Superfund monitoring program is the determination of the processes controlling the short-term particle dynamics within the estuary, especially in the region of the ETM. Studies done by Feng *et al.* (1999a, b) and Ciffroy *et al.* (2003) suggest that naturally occurring radionuclides can be used as tracers to understand the processes affecting particles dynamics in estuarine environments since the source terms and the rate of radioactive decay for these radionuclides are well known. Be-7 (half-life = 53 days) and Th-234 (half-life = 24 days), which have strong affinity for particle surfaces, were found useful in discerning short-term variations in the Hudson River Estuarine system. Th-234 is produced from Uranium-238 decay and a distribution coefficient (K_D) reported in the technical literature is summarized by Feng *et al.* (1999a) to be from 10^5 to 10^6. Th-234 production varies with salinity and Feng *et al.* (1999a) observed that if all other factors are equal, particles that scavenge Th-234 from higher salinity portion of the Hudson River estuary have higher excess Th-234 activities relative to those that are exposed to lower salinity water. Beryllium-7 (K_D approximately 10^5); however, is produced in the atmosphere by cosmic-ray spallation of nitrogen and oxygen, and atmospheric deposition is the main source to the estuary (Feng *et al.* 1999a). The different source functions of Th-234 and Be-7, along with their strong particle affinity and short half-lives, make them suitable for understanding the transport and fate of particles associated with contaminants in an estuarine system.

A distinctive feature of estuaries is the turbidity maximum zone, which is a region where the concentration of TSS may be a hundred times greater than concentrations both seaward and landward. There are several mechanisms responsible for the formation and maintenance of this region. Feng *et al.* (1999a, b) and Ciffroy *et al.* (2003) used natural radionuclides (Be-7 and Th-234) as tracers to understand the relative importance of local resuspension and lateral advection as sources to the ETM during the course of a tidal cycle, as well as the residence time of solids in the ETM (*e.g.*, Feng *et. al.*, 1999a,b; Ciffroy *et. al.*, 2003).

APPENDIX B
SEDFLUME THEORY

SedFlume Theory

Sedflume (McNeil, et al. 1996) is a straight flume that has a test section with an open bottom through which a circular cross-section coring tube containing sediment can be inserted (see Figure below). The main components of the flume are the coring tube; the test section; an inlet section for uniform, fully developed, turbulent flow; a flow exit section; a water storage tank; and a pump to force water through the system. The coring tube, test section, inlet section, and exit section are made of clear acrylic or polycarbonate so that the sediment-water interactions can be observed. The coring tubes are generally 50-60 cm long and have a 10 cm diameter round cross section. For these experiments, the coring tube will penetrate only 20-25 cm into the sediment bed.

Water is pumped directly from the water source (in this case, Newark Harbor or Passaic River), through a 5 cm diameter flexible hose, to the flow converter and then into the rectangular duct. The duct is 2.5 cm in height, 10 cm in width, and 120 cm in length; it connects to the 15 cm long test section. The flow converter changes the shape of the flow cross-section from circular to the rectangular duct shape while maintaining a constant cross-sectional area. A three-way valve regulates the flow so that part of the flow goes into the duct while the remainder returns to the water source. In addition, there is a small valve in the duct immediately downstream from the test section that is opened at higher flow rates to keep the pressure in the duct and over the test section at atmospheric conditions.

At the start of each test, the coring tube filled with sediment relatively undisturbed sediments extracted from the sediment bed. The sediment-filled coring tube is inserted into the bottom of the test section. An operator moves the sediment upward using the plunger, which is inside the coring tube and is connected to a jack. The jack is driven by motor, which is regulated with a switch. By this means, the sediment surface is raised and made level with the bottom of the test and inlet sections. The speed of the jack movement can be controlled at a variable rate in measurable increments as small as 0.5 mm.

Water is forced through the duct and the test section over the surface of the sediments. The shear produced by this flow, if great enough, causes the sediments to erode. As the sediments in the core erode, the core surface is moved upwards by the operator as necessary so that the sediment-water interface remains level with the bottom of the test and inlet sections. The erosion rate is recorded as the upward movement of the sediments in the coring tube over time. Duration of each erosion test for a specified shear stress is dependent on the rate of erosion and generally is between 0.5 and 10 minutes. After the initial test is performed at low shear stress, the operator increases flow to a specified higher rate and again records erosion results. This is continued until erosion is significant, at which point the flowrate is decreased to the initial value and the series of erosion experiments with increasing stress is performed again. This method provides data on erosion rate for specified shear stresses and their variation with depth. In addition, samples are collected from the core at pre-determined depths to collect depth-variable bulk property data.

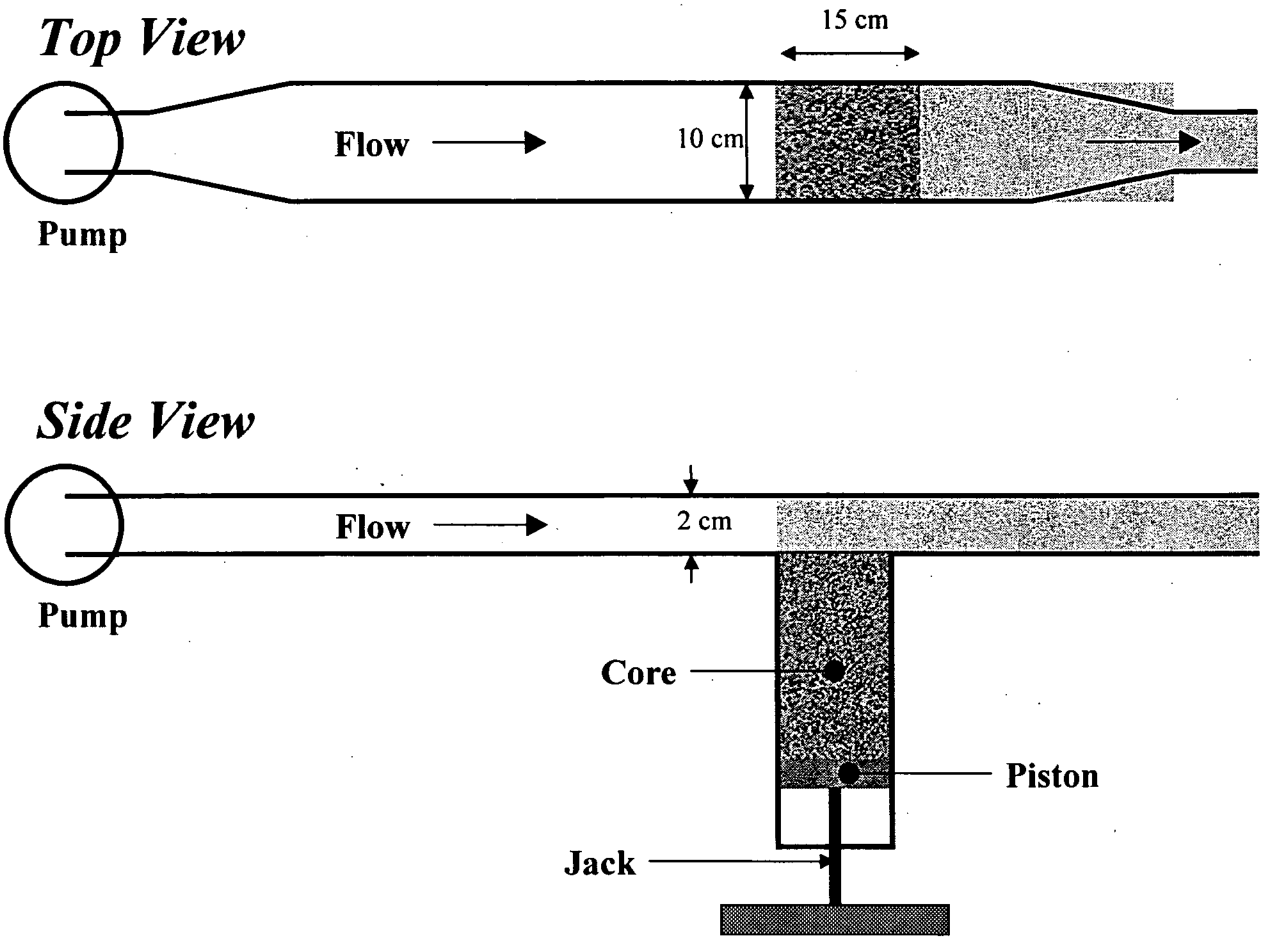


Figure 1: SedFlume Configuration

MALCOLM PIRNIE

Preliminary Sampling Locations

To: Passaic River Superfund Team **Date:** May 12, 2005

Copy:

From: Solomon Tugbawa, MPI
Larry Sanford, HQI
Nicholas Kim, HQI
Cindy How, MPI

Re: Preliminary Sampling locations for Sedflume and Gust Microcosm

---

Rationale for Selecting Site Locations

The criteria used to select preliminary locations include:

1) Samples should be representative of the different hydrological regimes (*i.e.* intertidal and subtidal areas).

2) Samples should be representative of the range of sediment bed properties (e.g., grain size distribution).

3) Sample locations should be situated in depositional areas with the potential for high shear stress during episodic events.

4) Areas of high contaminant inventories, especially in the Harrison Reach are important.

5) Sample locations should include areas both inside and outside the range of the salt wedge, such that potential influences of the salt wedge on the deposition and erosion behavior can be observed. Since the salt wedge is dependent on flow conditions, this document assumes that the area down-estuary of the Newark Reach represents the salt-wedge area.

6) Some samples will be co-located with previous TSI Sedflume locations.

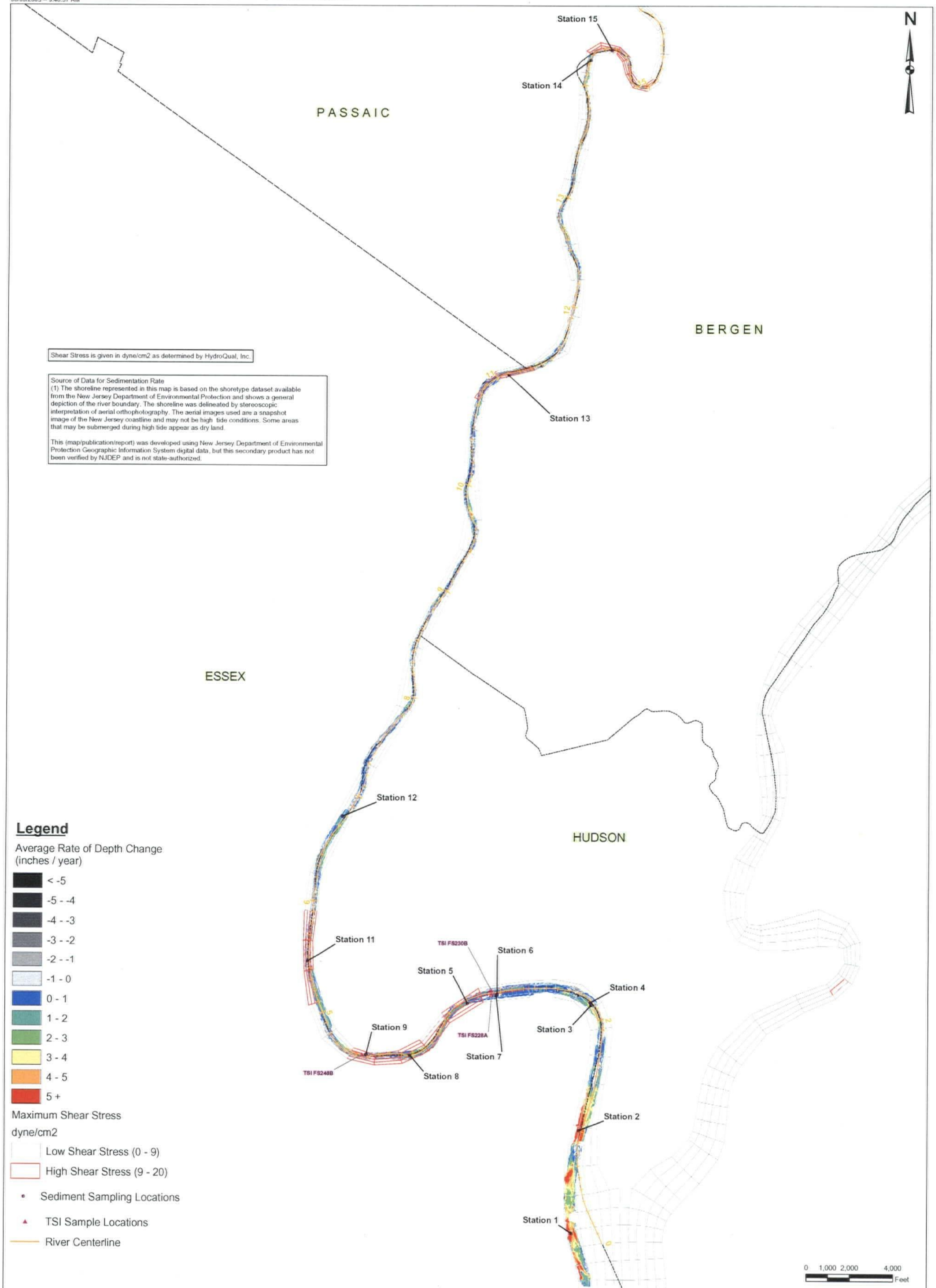
7) For Gust Microco sm, an important condition is that the location should be predominantly fine grained sediments.

Preliminary Site Locations

The 15 preliminary sites selected are depicted on Figure 1 and are summarized below. (Note SM = Sedflume and Gust Microcosm; S = Sedflume only).

Site #	Northing (ft)	Easting (ft)	River Mile	Distance from the Centerline (ft)	Rationale #	Experiment
1	684237.3178	596832.6144	0.18	1227.281	3,4,5,7	SM
2	689026.4238	597200.282	1.01	134.0229	3,4,5	S
3	695025.6685	597470.1327	2.24	117.9354	1,2,3,4,5,7	SM
4	694928.0482	597323.7023	2.24	281.9693	1,2,3,4,5	S
5	695244.3746	593180.5835	3.08	77.16227	1,2,3,4,5,6,7	SM
6	695355.4015	593163.4918	3.08	35.17238	1,2,3,4,5,7	SM
7	695458.4131	593149.9908	3.08	139.0349	1,2,3,4,5,6	S
8	692475.6882	589575.4217	4	22.49453	3	S
9	692342.5083	587206.7315	4.45	7.135216	3,5,7	SM
10	692454.8904	587218.8191	4.45	105.6863	1,3,5,6	S
11	696700.5892	584711.7335	5.46	67.12603	3,4	S
12	702878.8944	586124.3201	6.68	49.37506	3,5	S
13	723074.5175	592790.0839	10.89	36.39364	3,5	S (M?)
14	738434.978	597854.1652	14.34	90.0607	3,5	S (M?)
15	738398.3778	598574.3137	14.48	33.22653	3,5	S

Map Document: (S:\Projects\PASSAIC\MapDocuments\MXD\SedimentErosionExperimentSites_shear stress rev080505.mxd)
08/05/2005 -- 9:48:57 AM



MALCOLM PIRNIE

LOWER PASSAIC RESTORATION PROJECT
SITE LOCATION FOR
SEDIMENT EROSION EXPERIMENTS
AND MAXIMUM SHEAR STRESS

MAY 2005

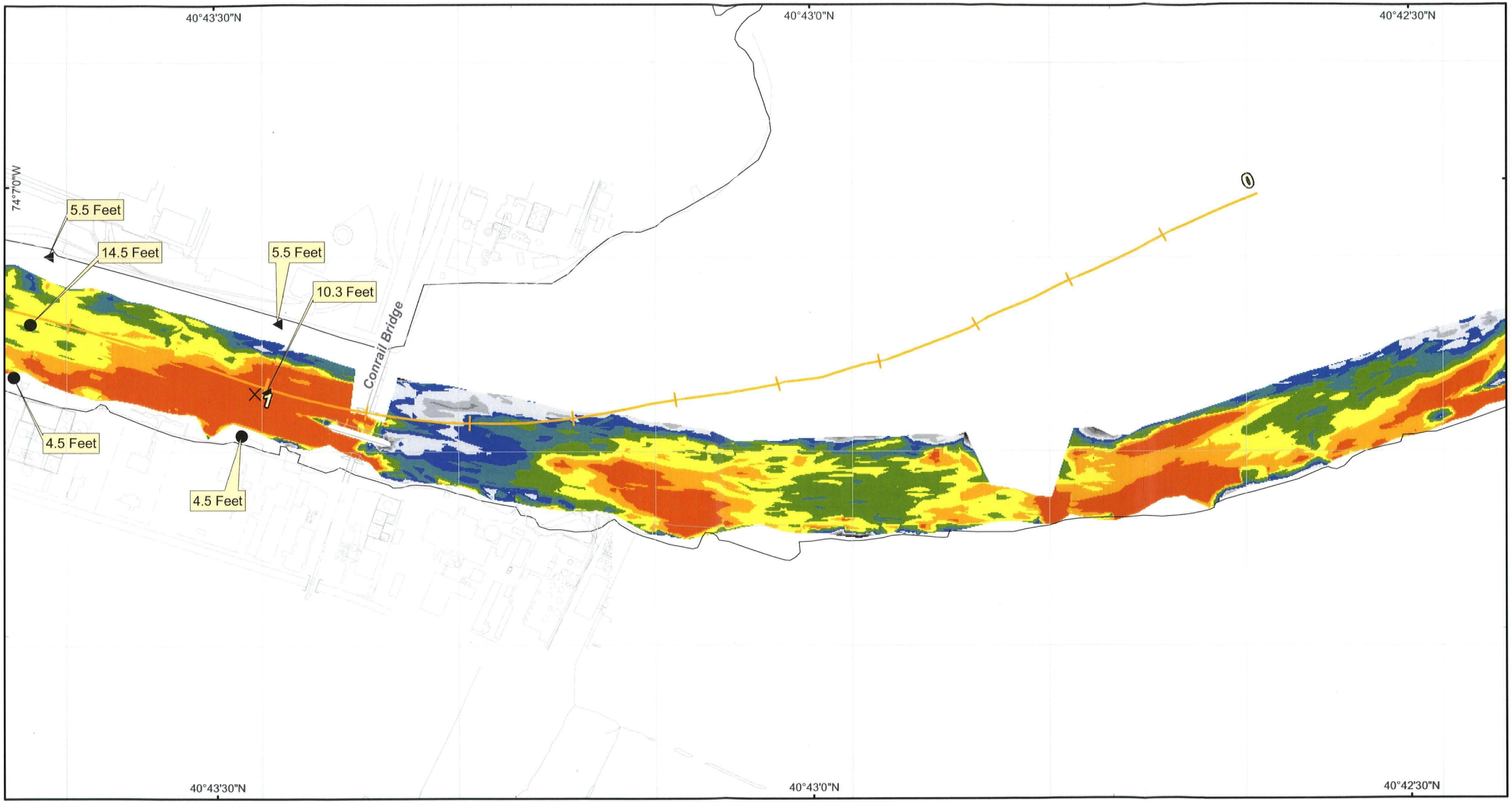
FIGURE 1

Attachment 3
High Resolution Sediment Core Site Selection Data

Information used to guide High Resolution Core Location Selection Including:
Sedimentation Rates
Surface Sediment Texture
Fence Diagrams
2005 Sediment Sampling and Radiological Results

Sedimentation Rates

One-mile-per-plate map book containing (1) sedimentation rates calculated using the 1989 and 2004 bathymetric surveys [refer to Attachment B of the Work Plan (Malcolm Pirnie, Inc. 2005a) for more details on method] and (2) depth of total DDT contamination calculated using the Tierra Solutions, Inc. 1995 data set [refer to Section 4.2.2 of the Field Sampling Plan Volume 1 (Malcolm Pirnie, Inc. 2005b) for more details on method]. Note that sedimentation data extend to RM 15 and total DDT data extend to RM 6.7.



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

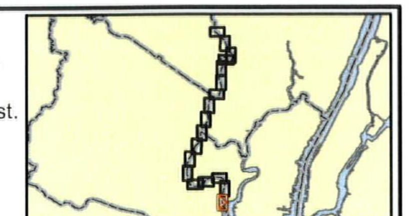
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

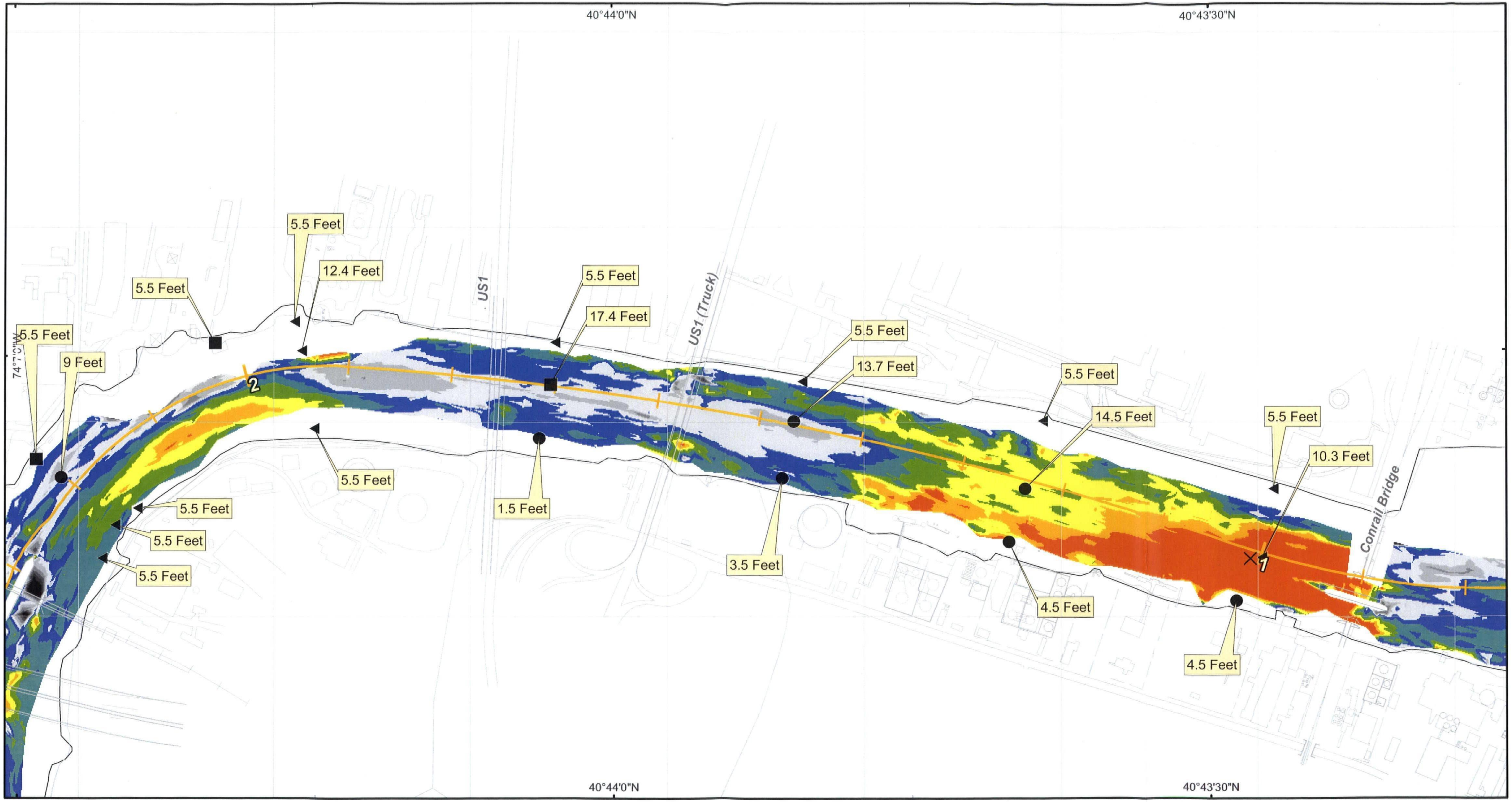
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 0 to 1

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data
- Depth of Contamination (Feet) marked in call-out boxes.
- River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

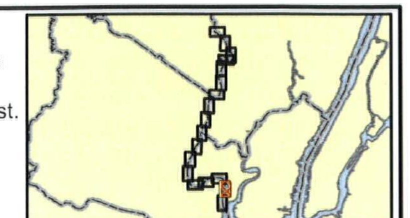
0 250 500 1,000

1 " equals 500 '

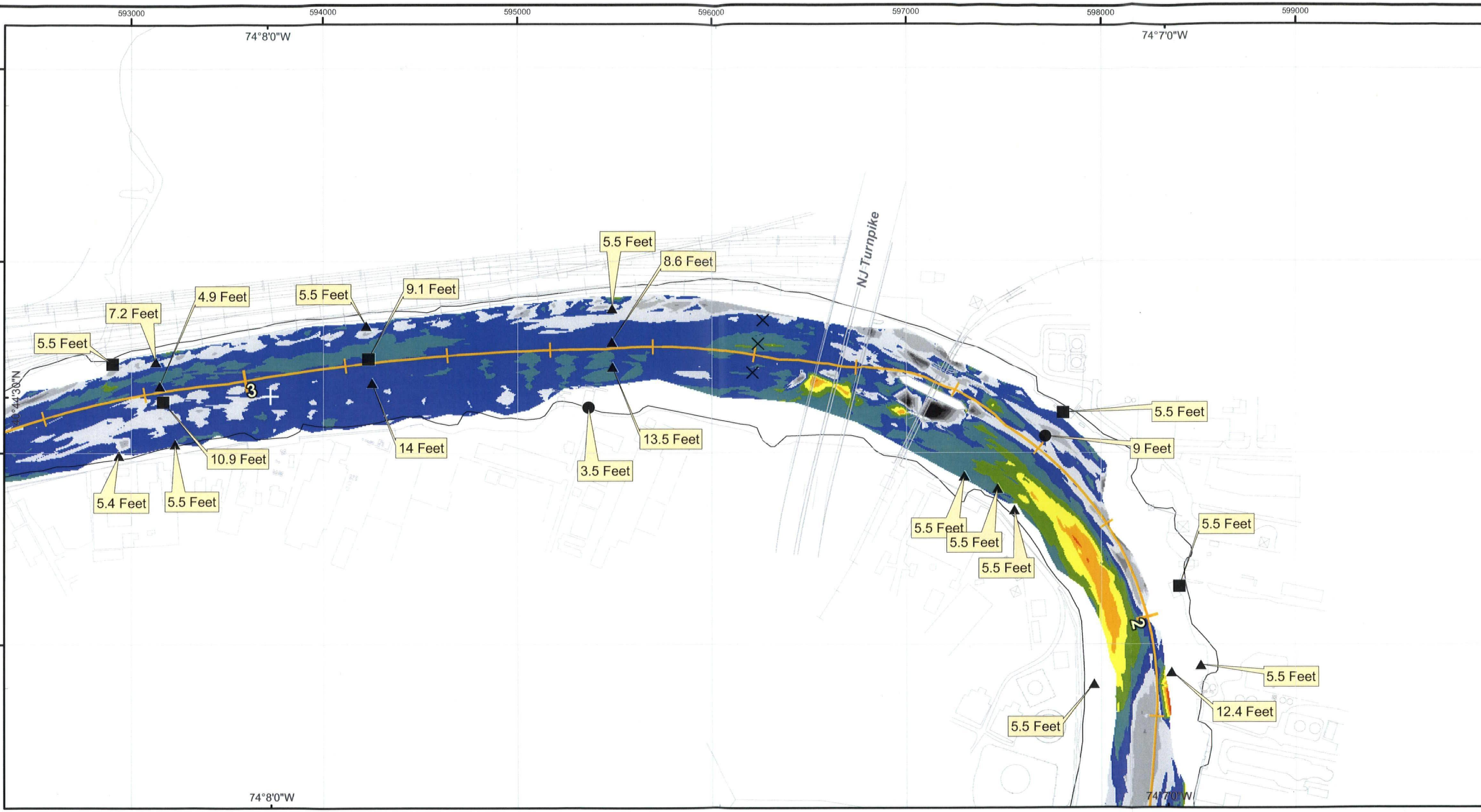
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 1 to 2



Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

US Army Corps of Engineers

MALCOLM PIRNIE

Legend

Sedimentation Rate (Inches per Year)
- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

0 250 500 1,000

1 " equals 500 '

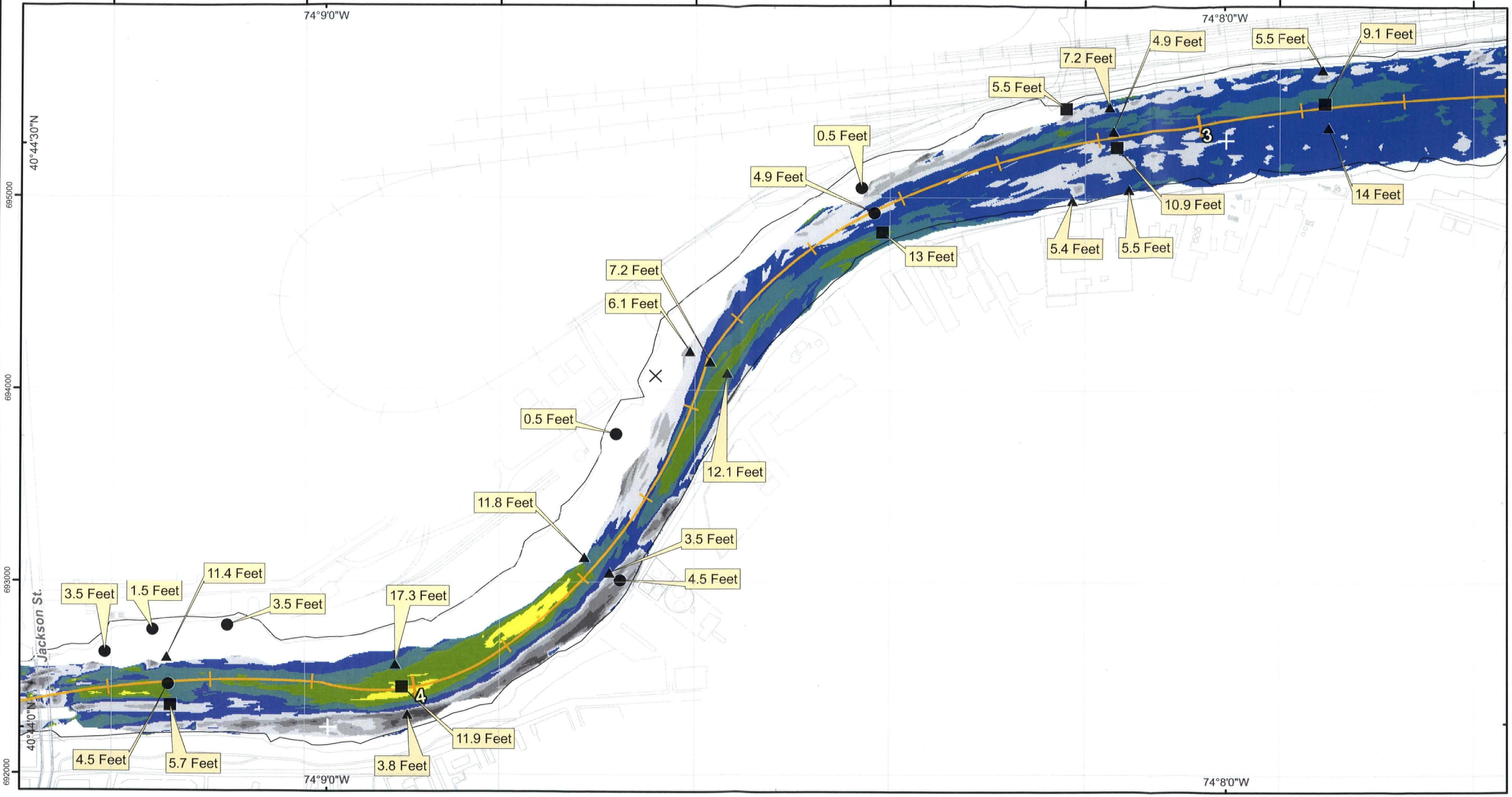
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 2 to 3

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

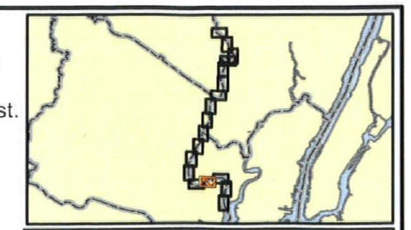
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

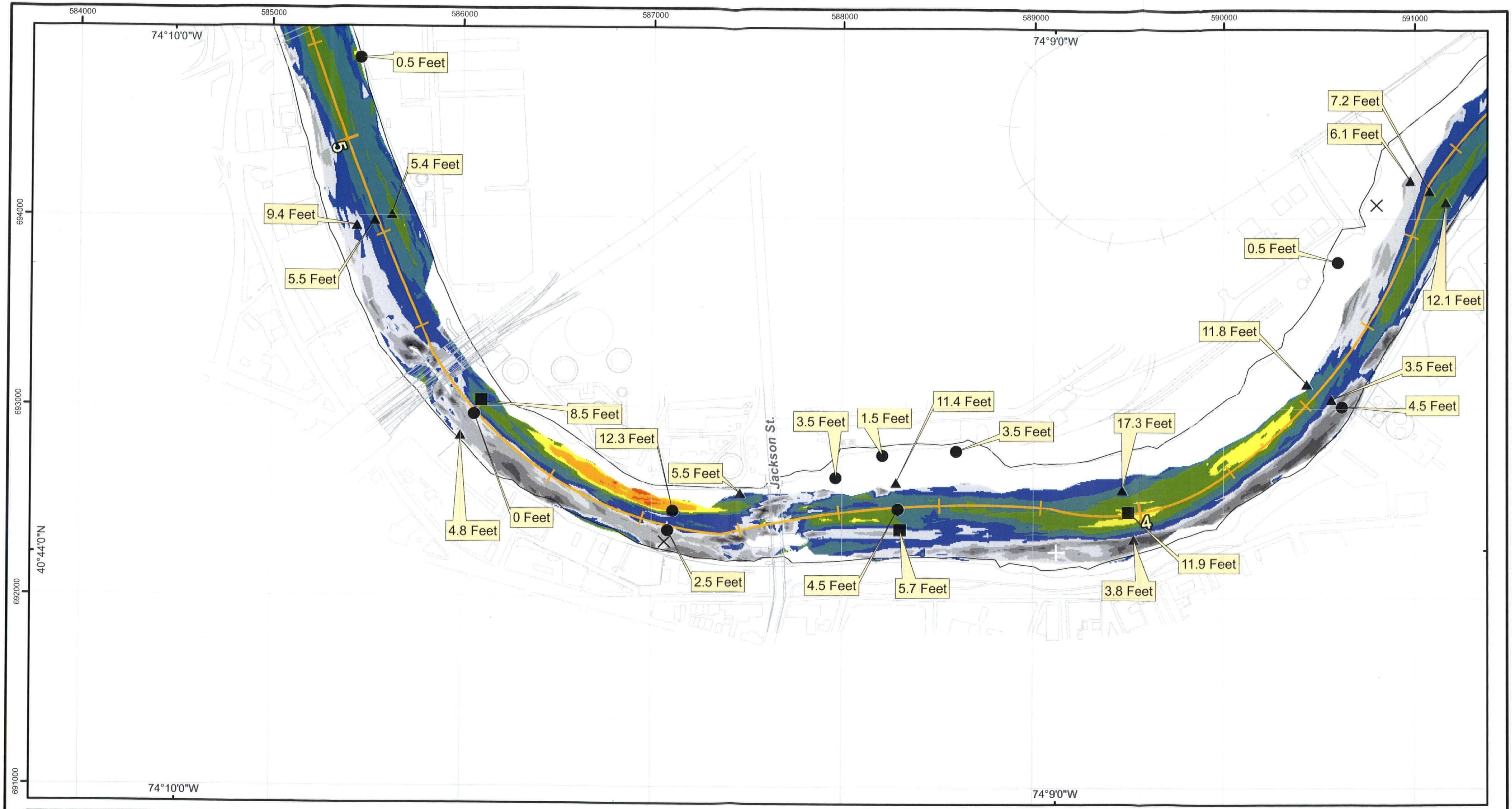
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 3 to 4

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



Lower Passaic River
Restoration Project
New Jersey

Sedimentation Rate (1989-2004)
& Depth of Total
DDT Contamination

US Army Corps of Engineers

MALCOLM PIRNIE

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

0 250 500 1,000

1 " equals 500 '

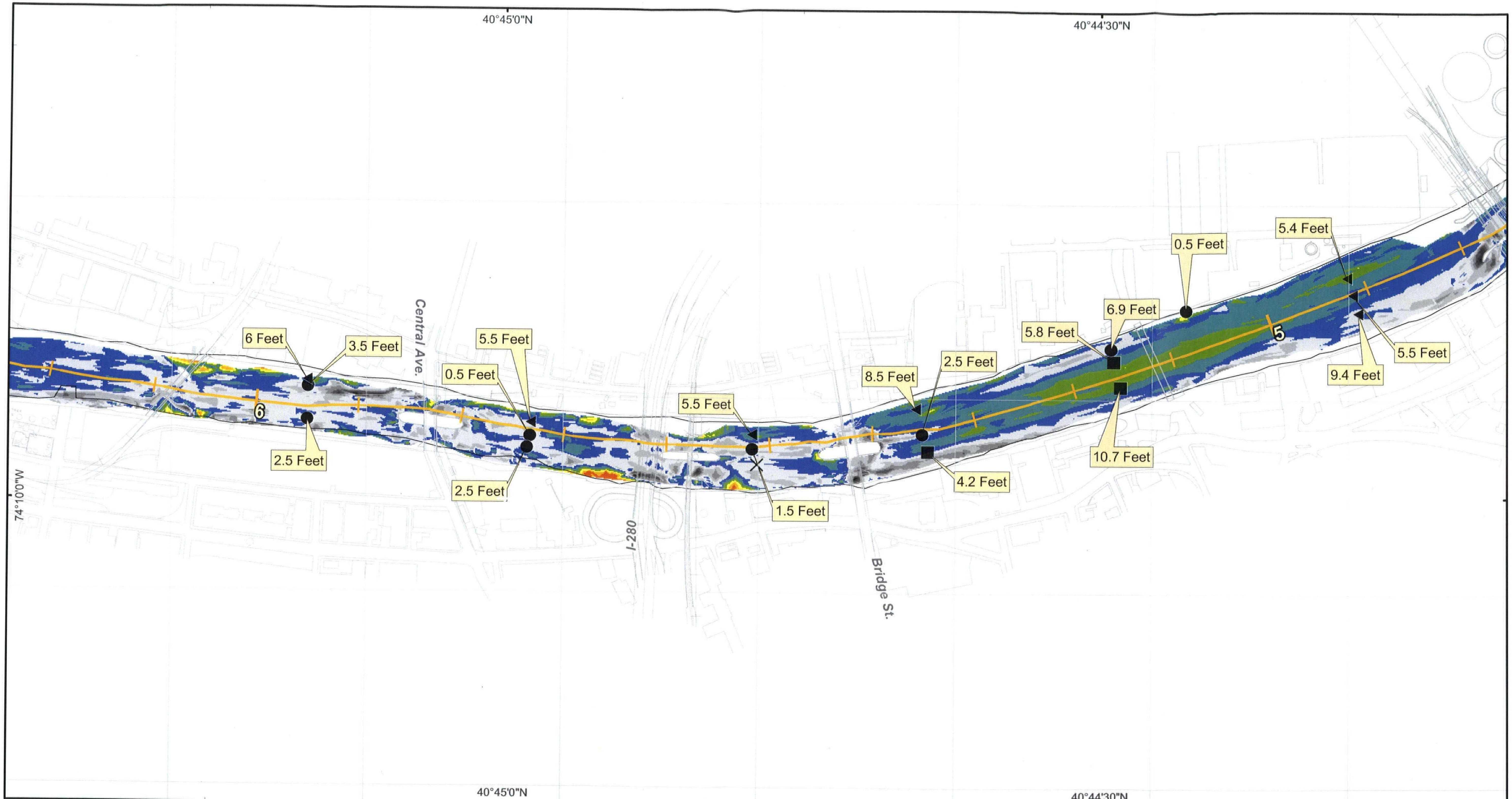
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 4 to 5

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



Lower Passaic River Restoration Project
New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

US Army Corps of Engineers

MALCOLM PIRNIE

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data
- Depth of Contamination (Feet) marked in call-out boxes.
- River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

0 250 500 1,000

1 " equals 500 '

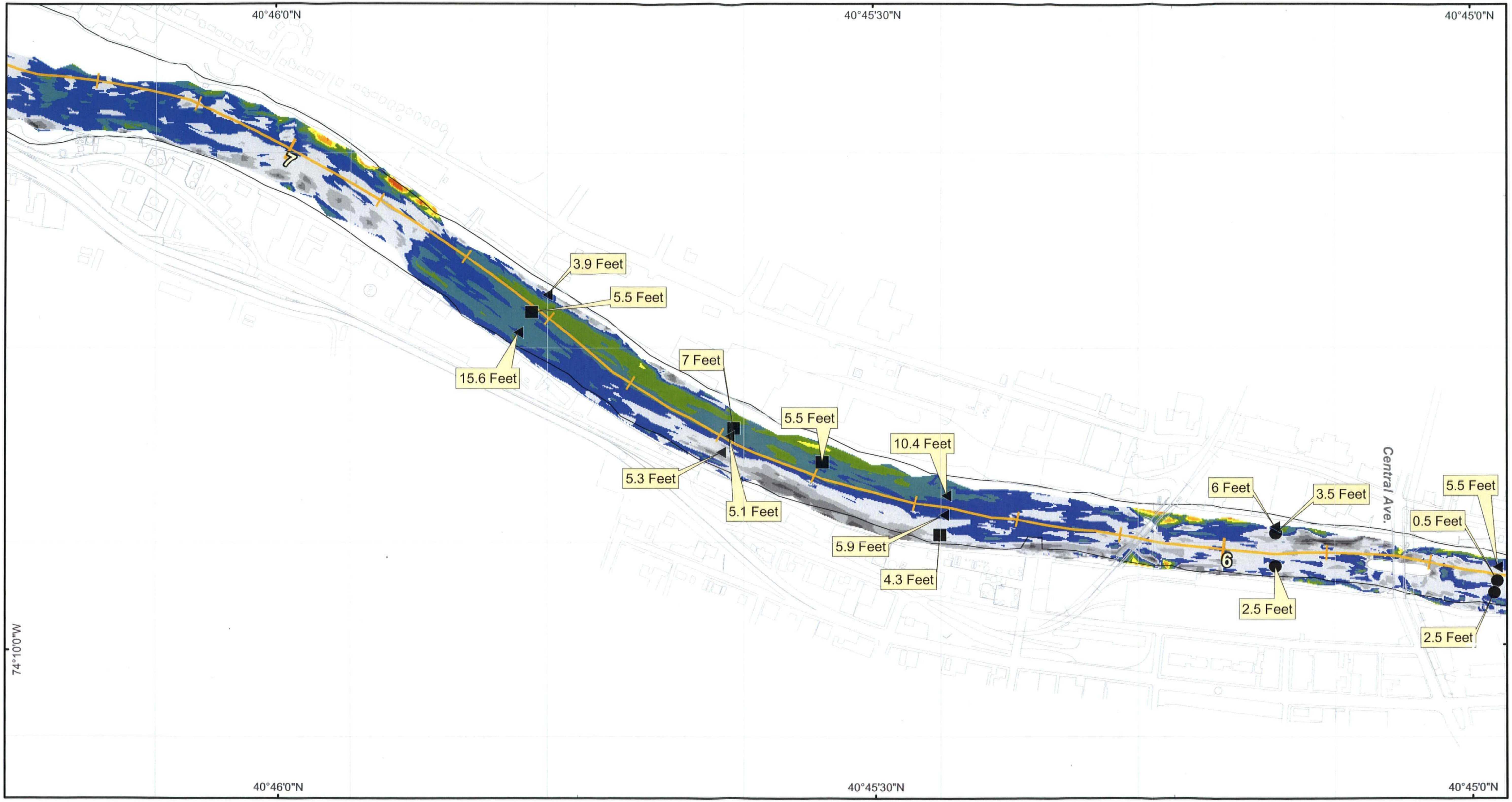
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 5 to 6

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project
New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate (Inches per Year)

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data
- Depth of Contamination (Feet) marked in call-out boxes.
- River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

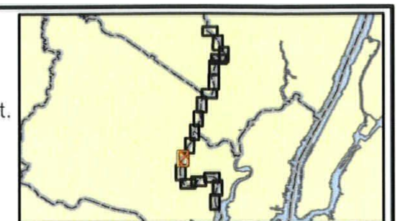
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

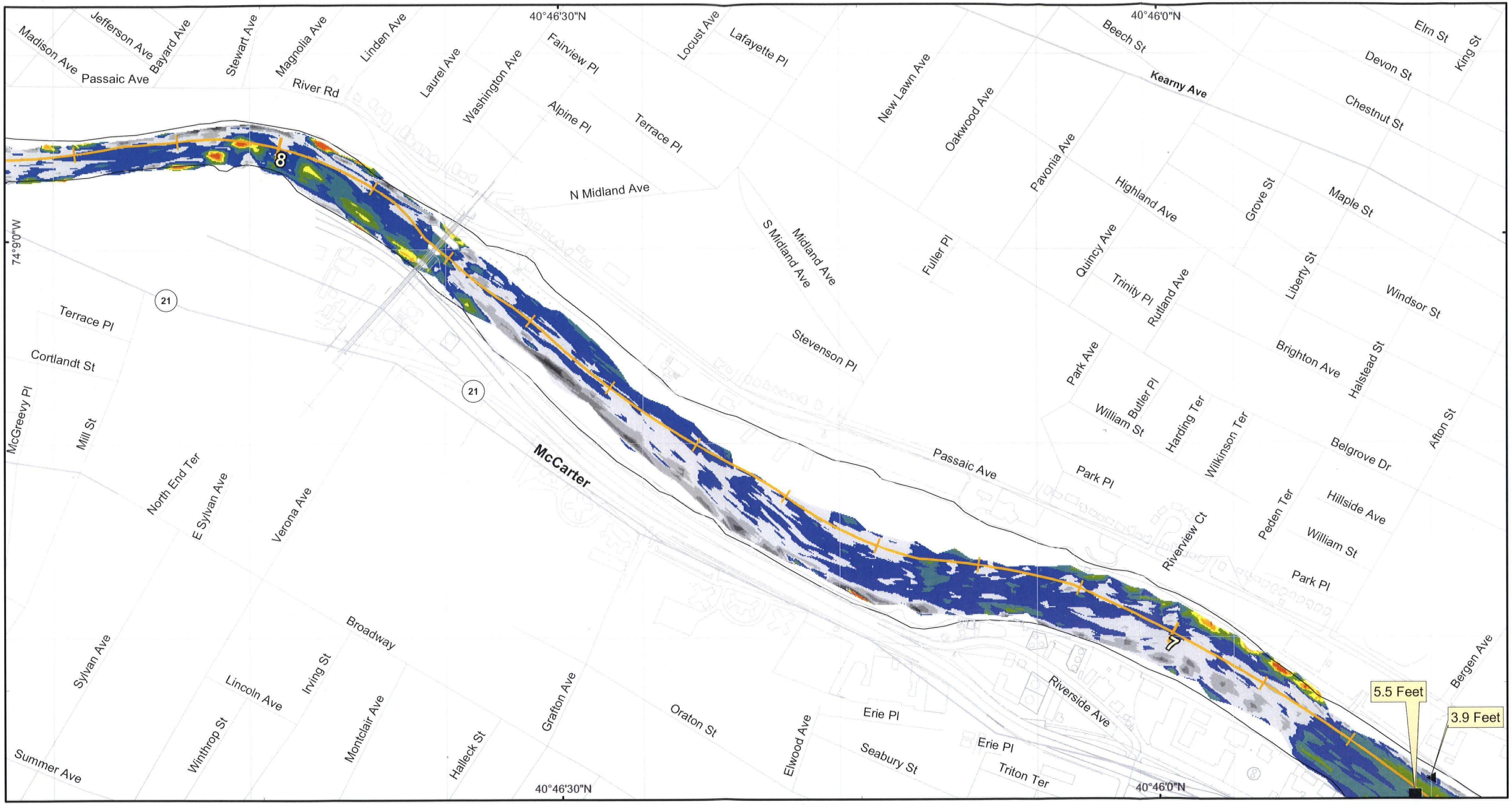
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 6 to 7

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- \> 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

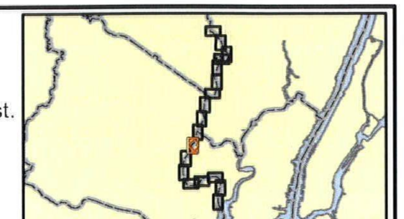
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

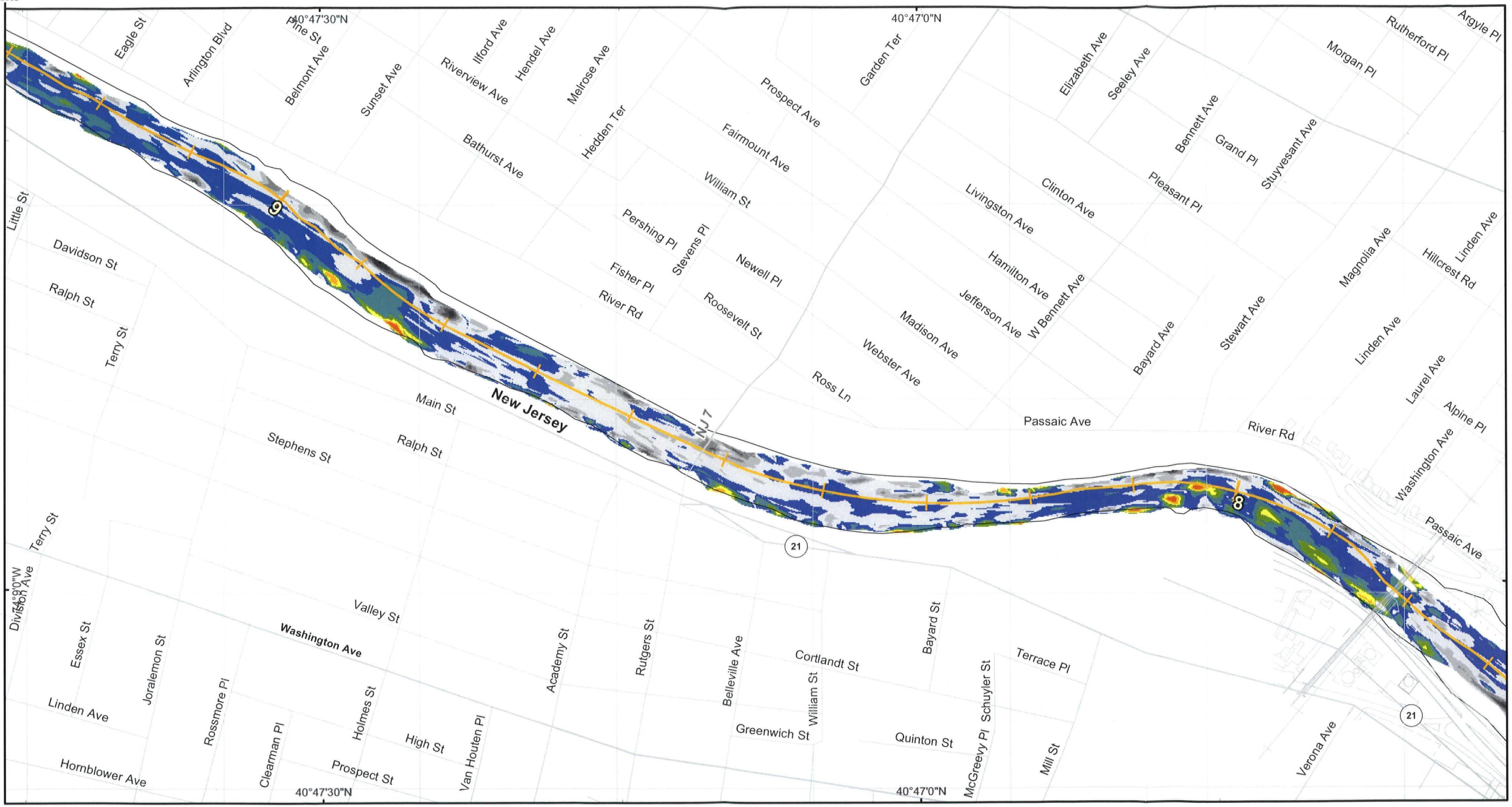
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 7 to 8

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

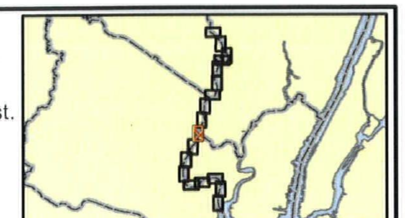
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

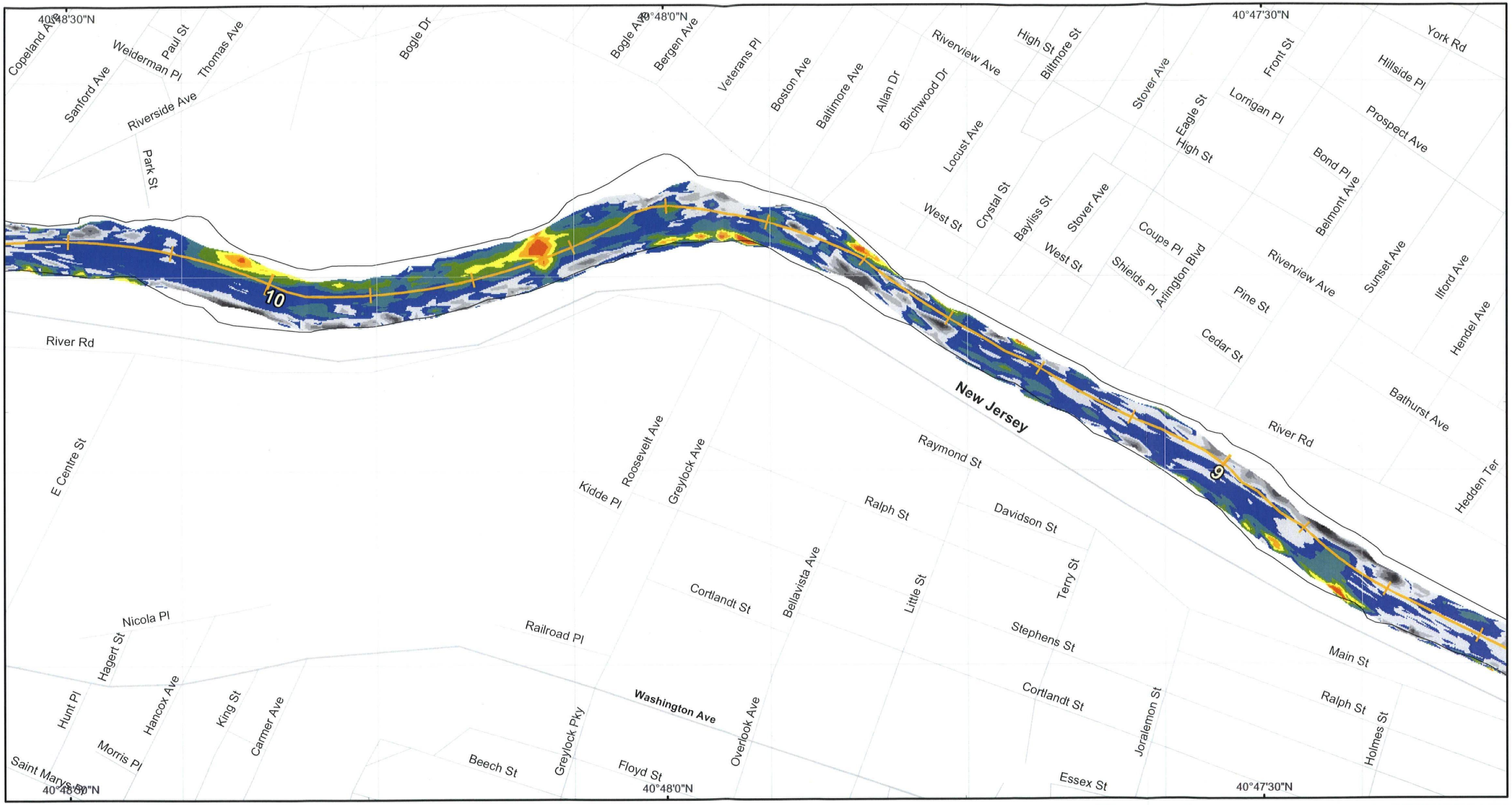
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 8 to 9

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate (Inches per Year)

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

0 250 500 1,000

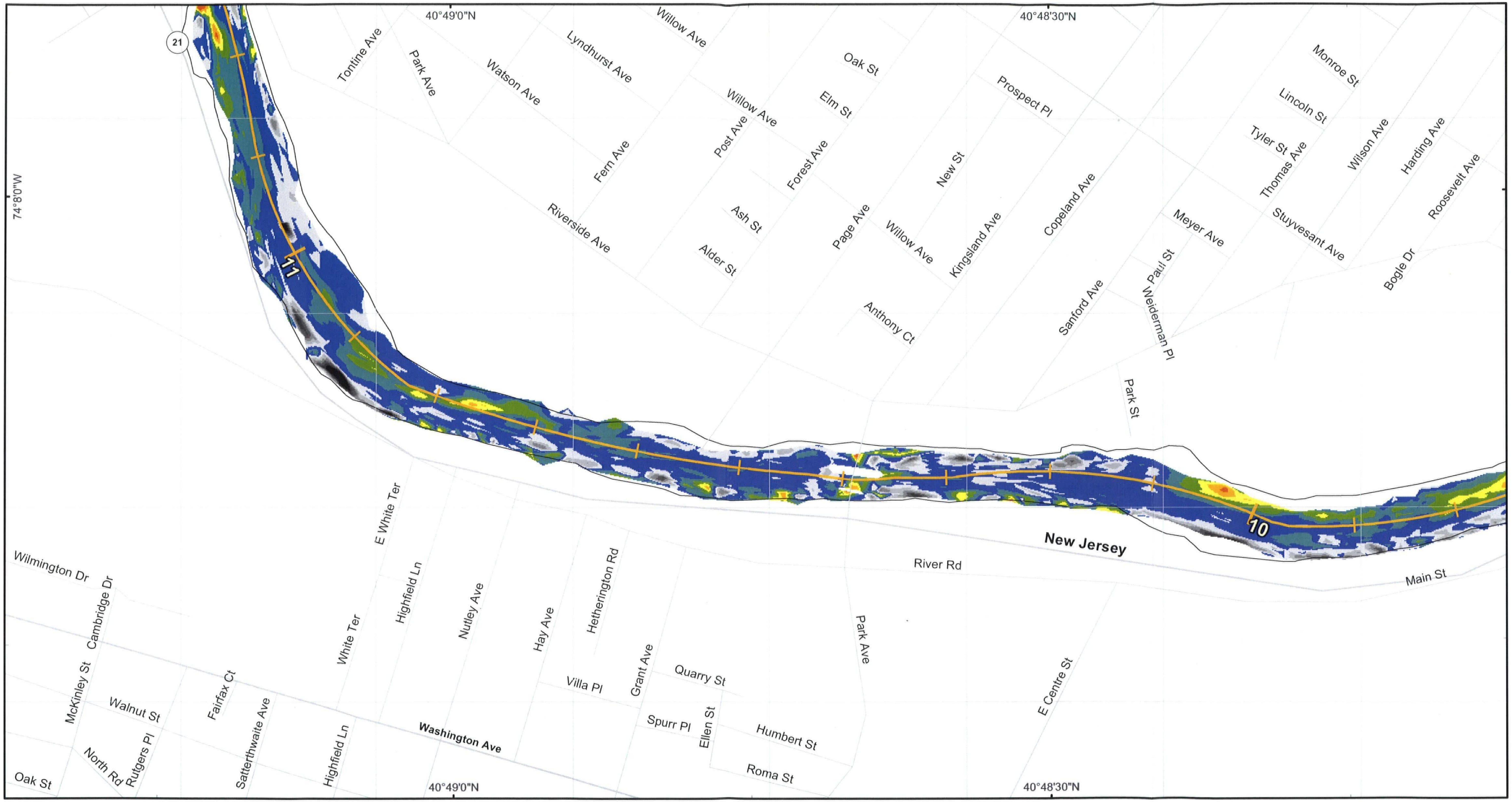
1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 9 to 10



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

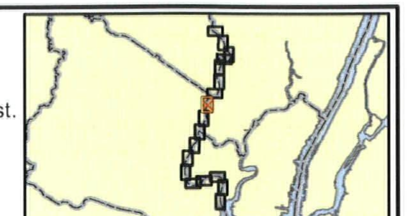
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

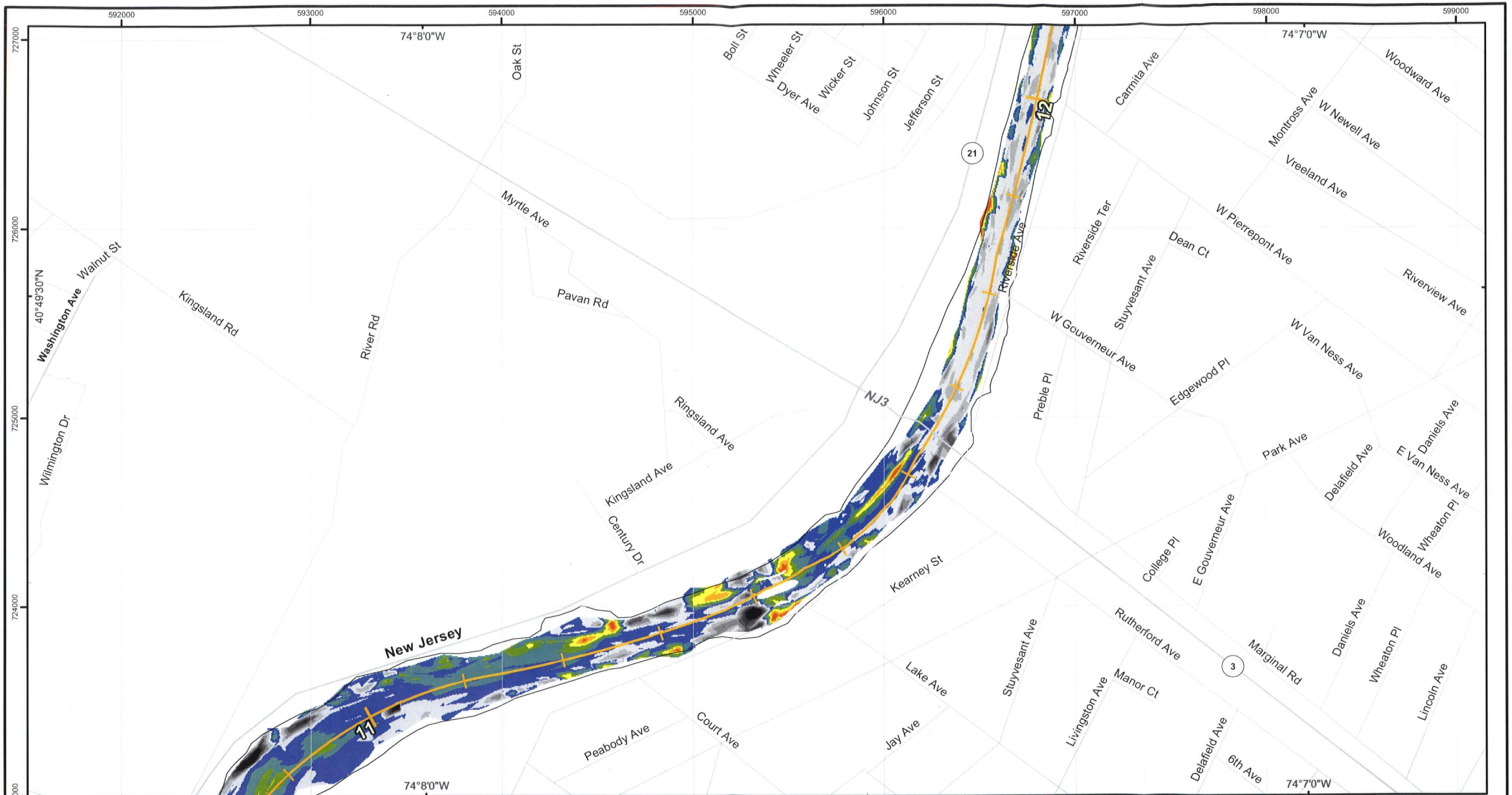
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 10 to 11

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

**Sedimentation Rate (1989-2004)
& Depth of Total
DDT Contamination**

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- \> 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

- River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

0 250 500 1,000

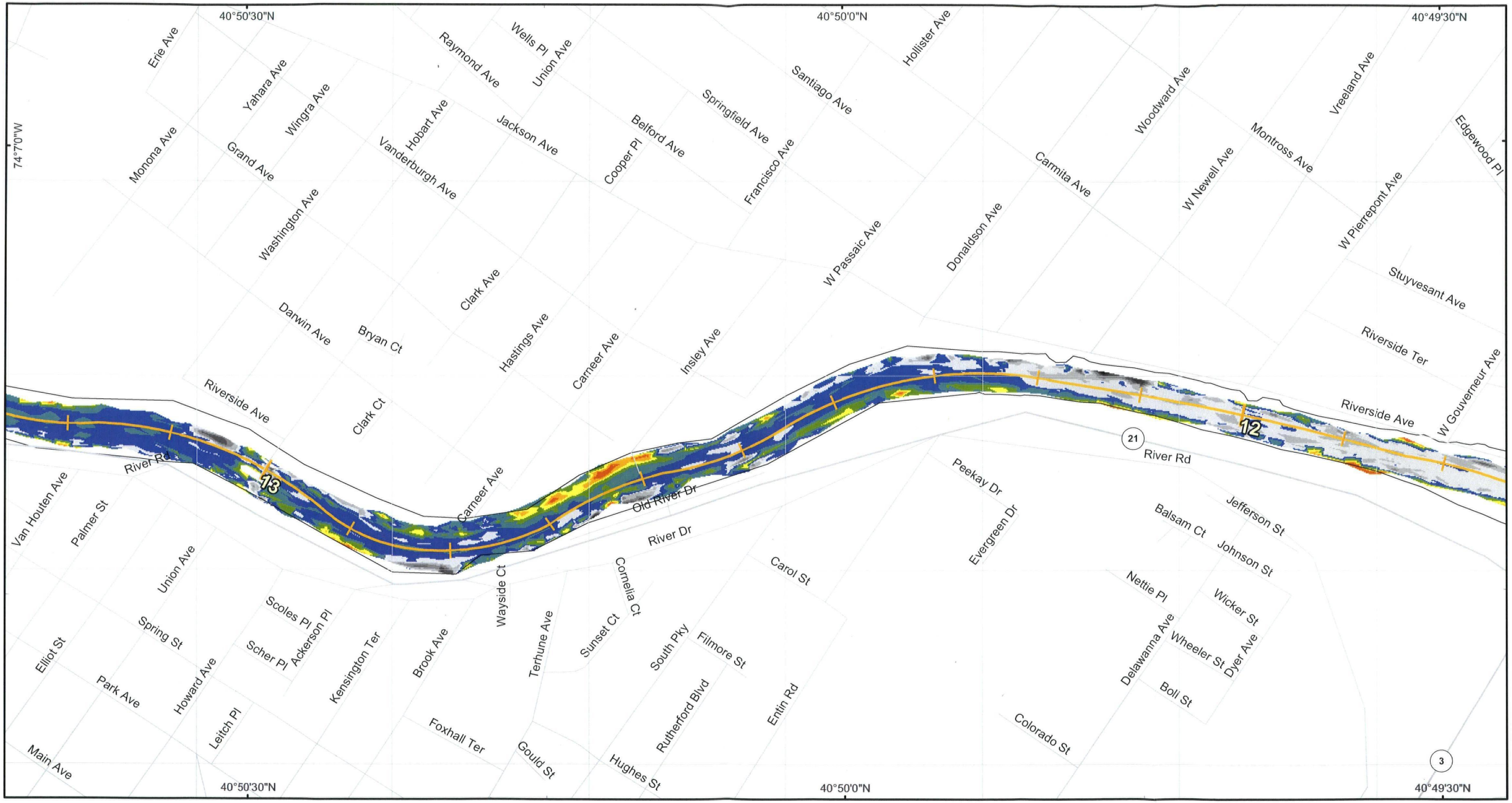
1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 11 to 12



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project
New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

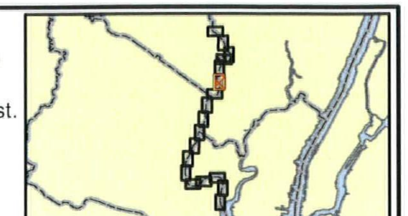
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

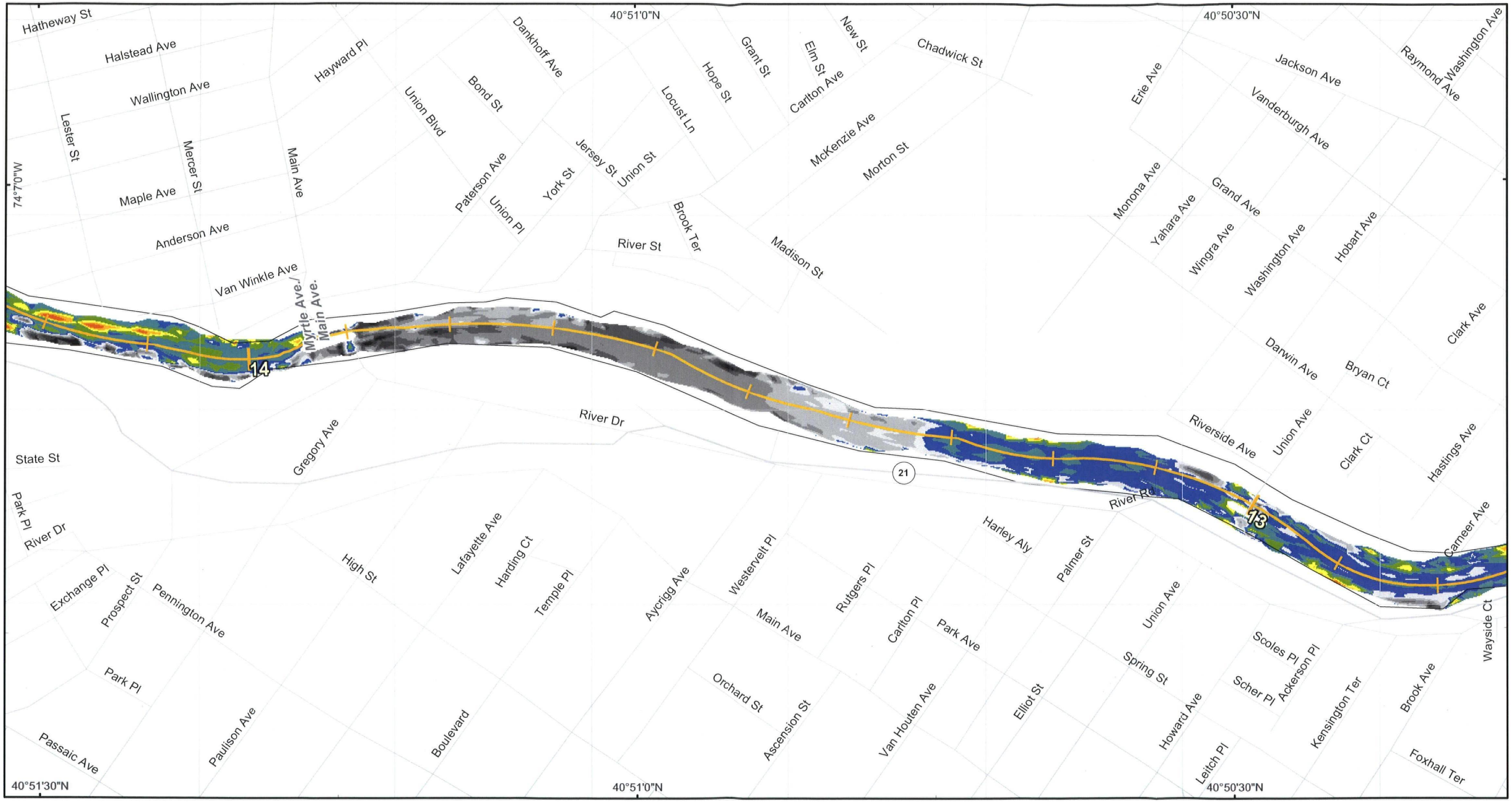
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 12 to 13

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project
New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

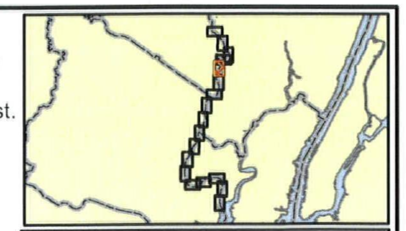
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

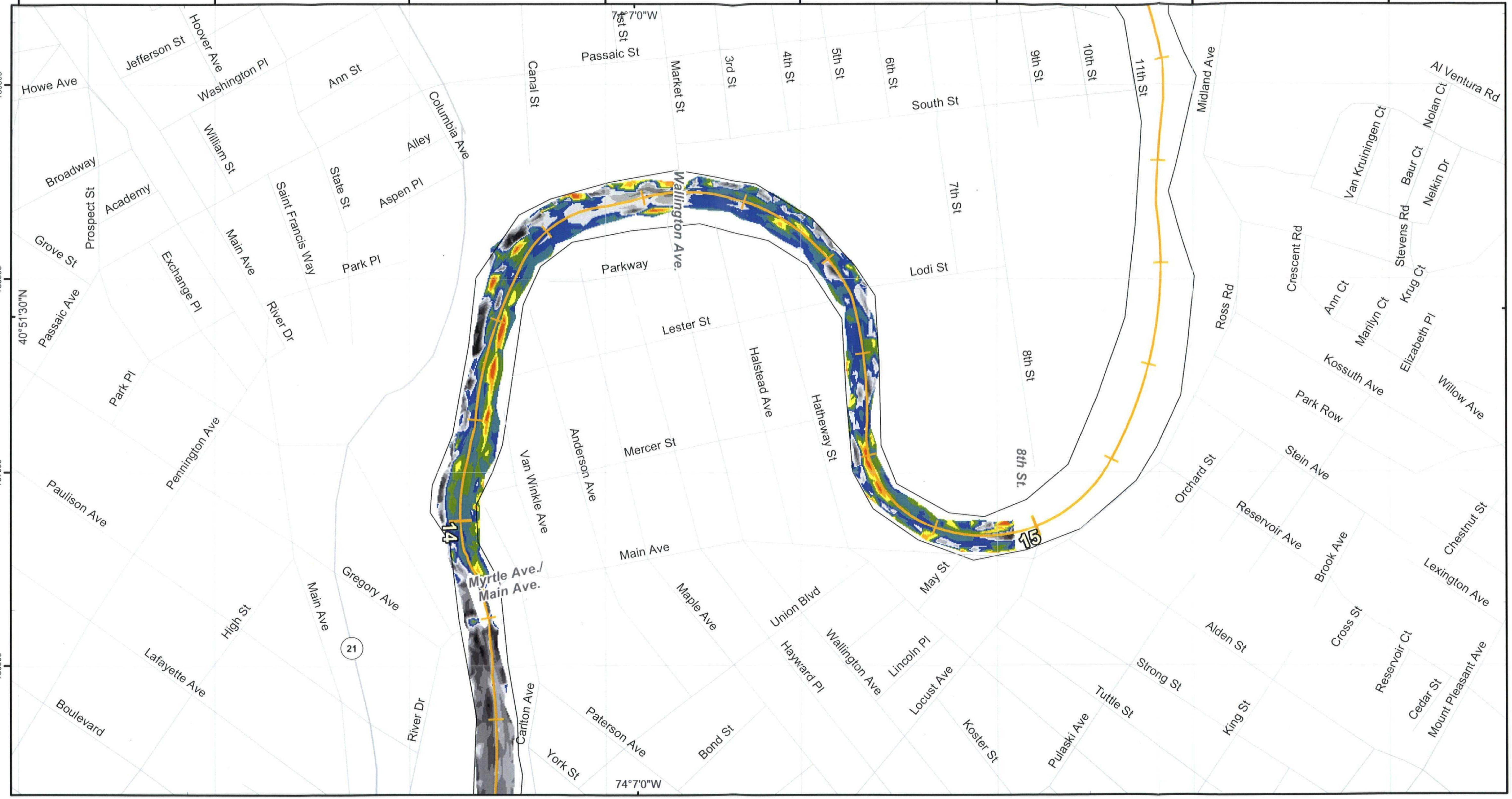
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 13 to 14

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

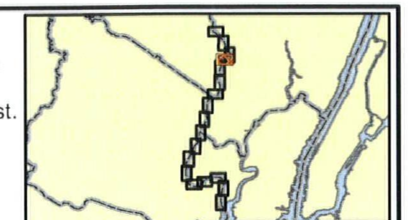
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

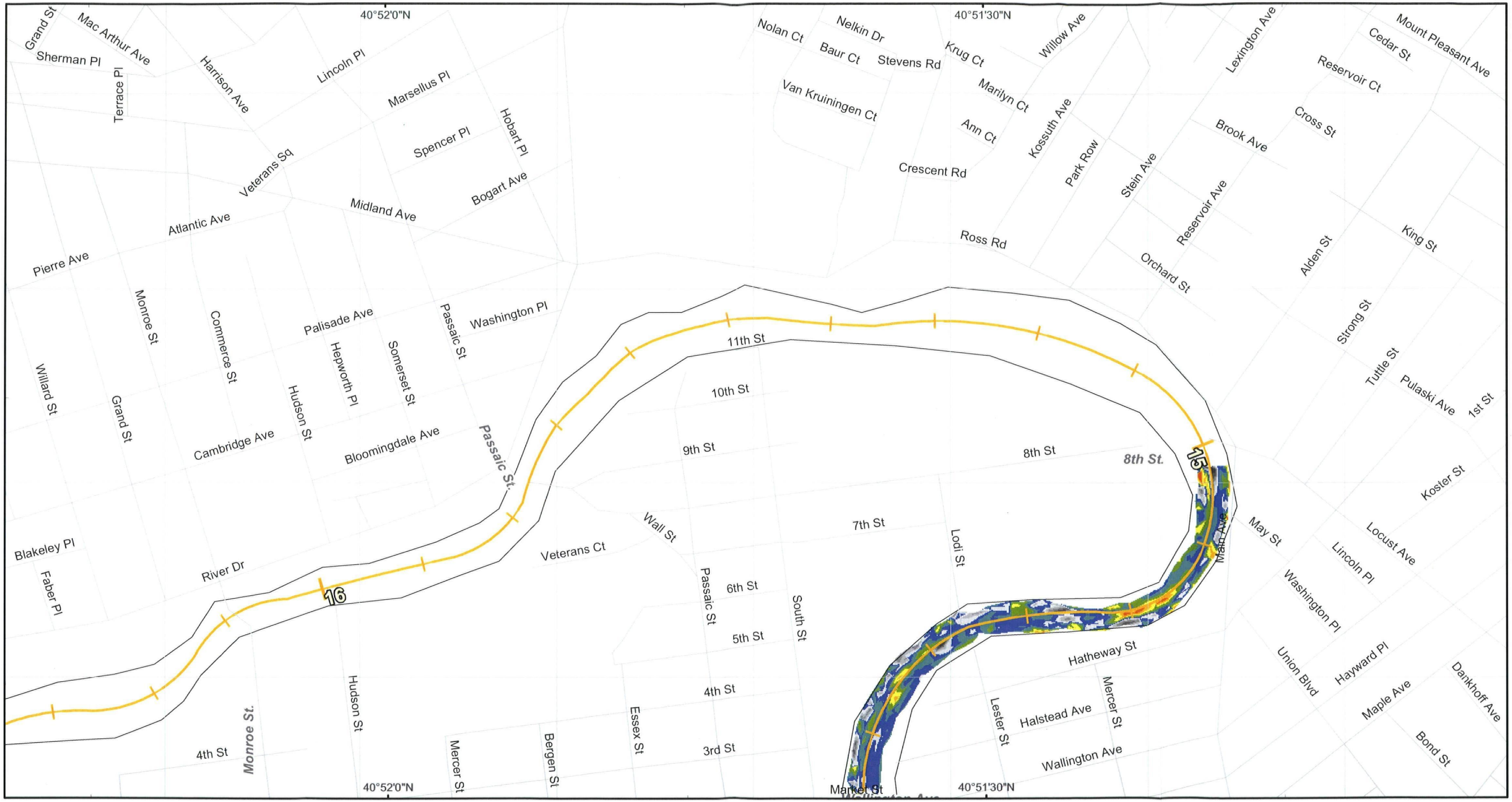
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 14 to 15

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

**Sedimentation Rate (1989-2004)
& Depth of Total
DDT Contamination**

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

Total DDT Coring Location
- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

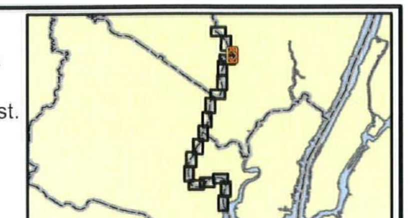
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

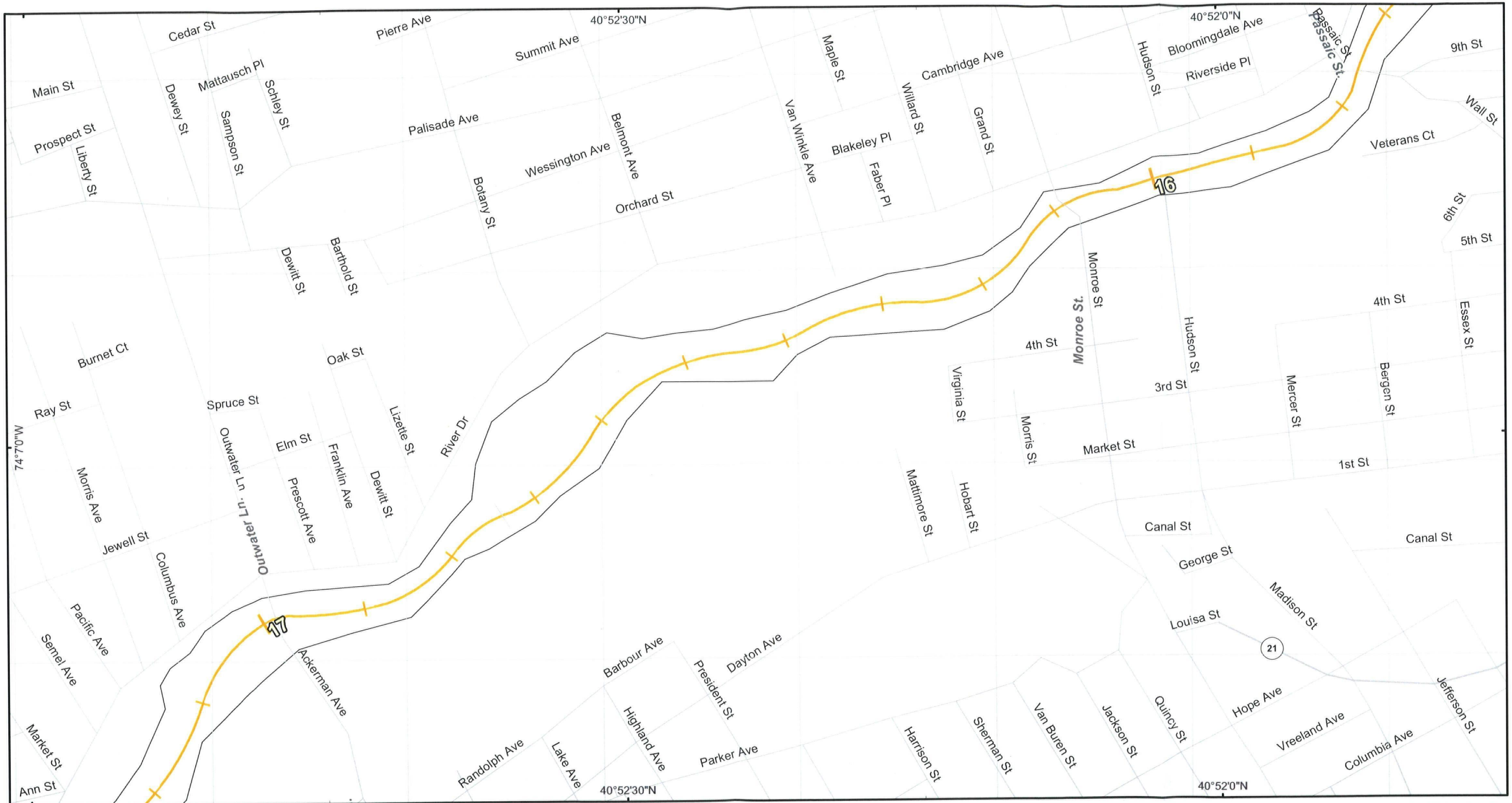
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 15 to 16

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate (Inches per Year)

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

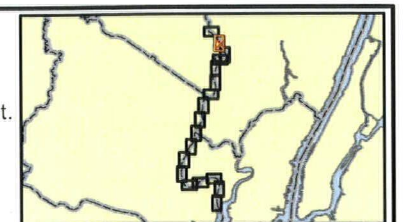
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

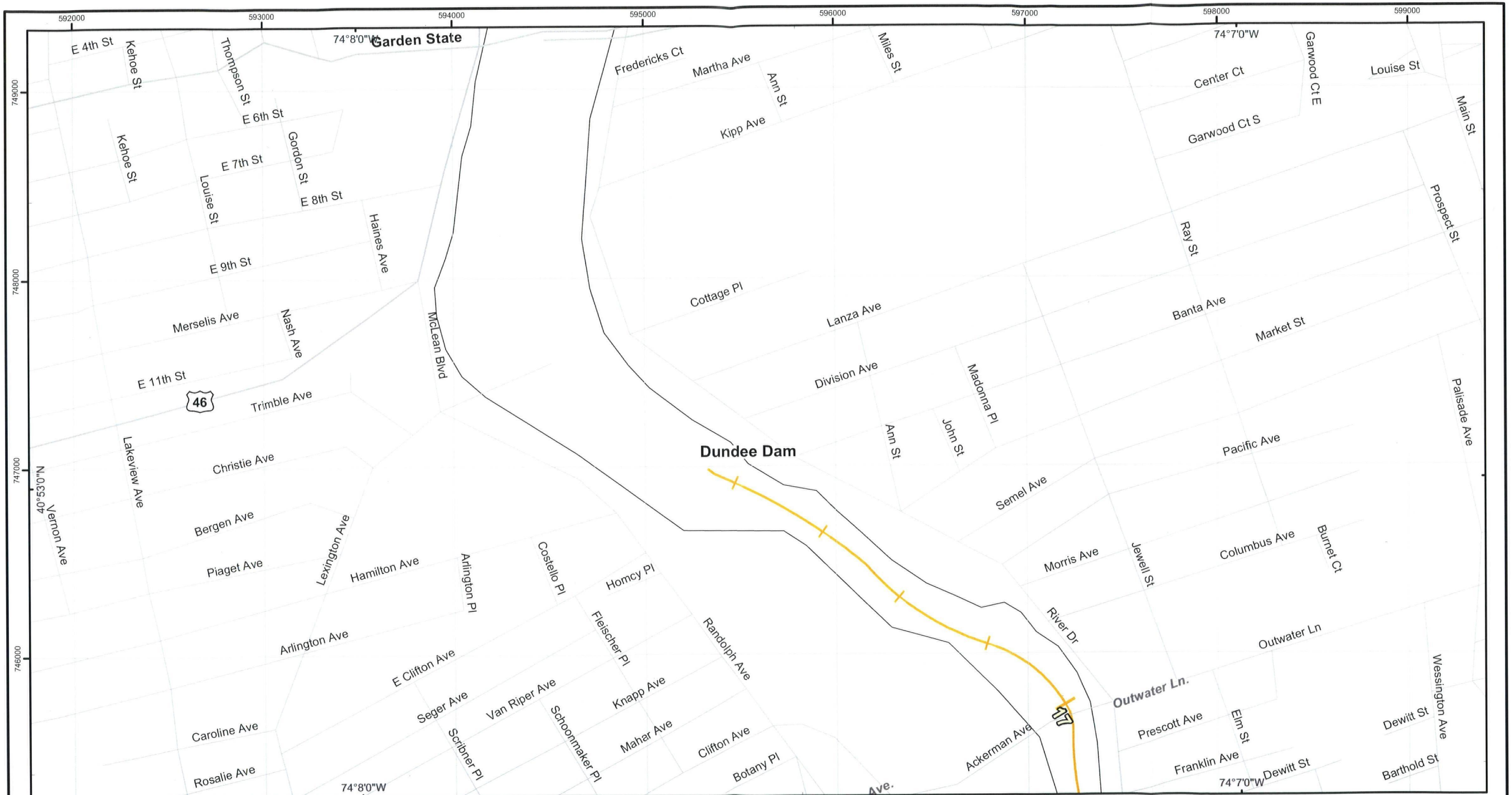
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 16 to 17

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sedimentation_Rate_GeochemEval_November_2005.mxd)
10/26/2005 -- 1:08:41 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sedimentation Rate (1989-2004) & Depth of Total DDT Contamination

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

Total DDT Coring Location

- Complete Core
- Incomplete Rising Core
- Incomplete Declining Core
- No Data

Depth of Contamination (Feet) marked in call-out boxes.

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

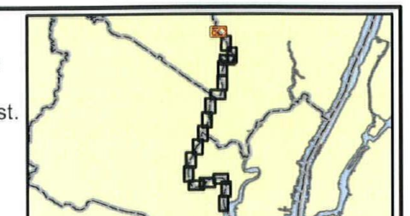
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

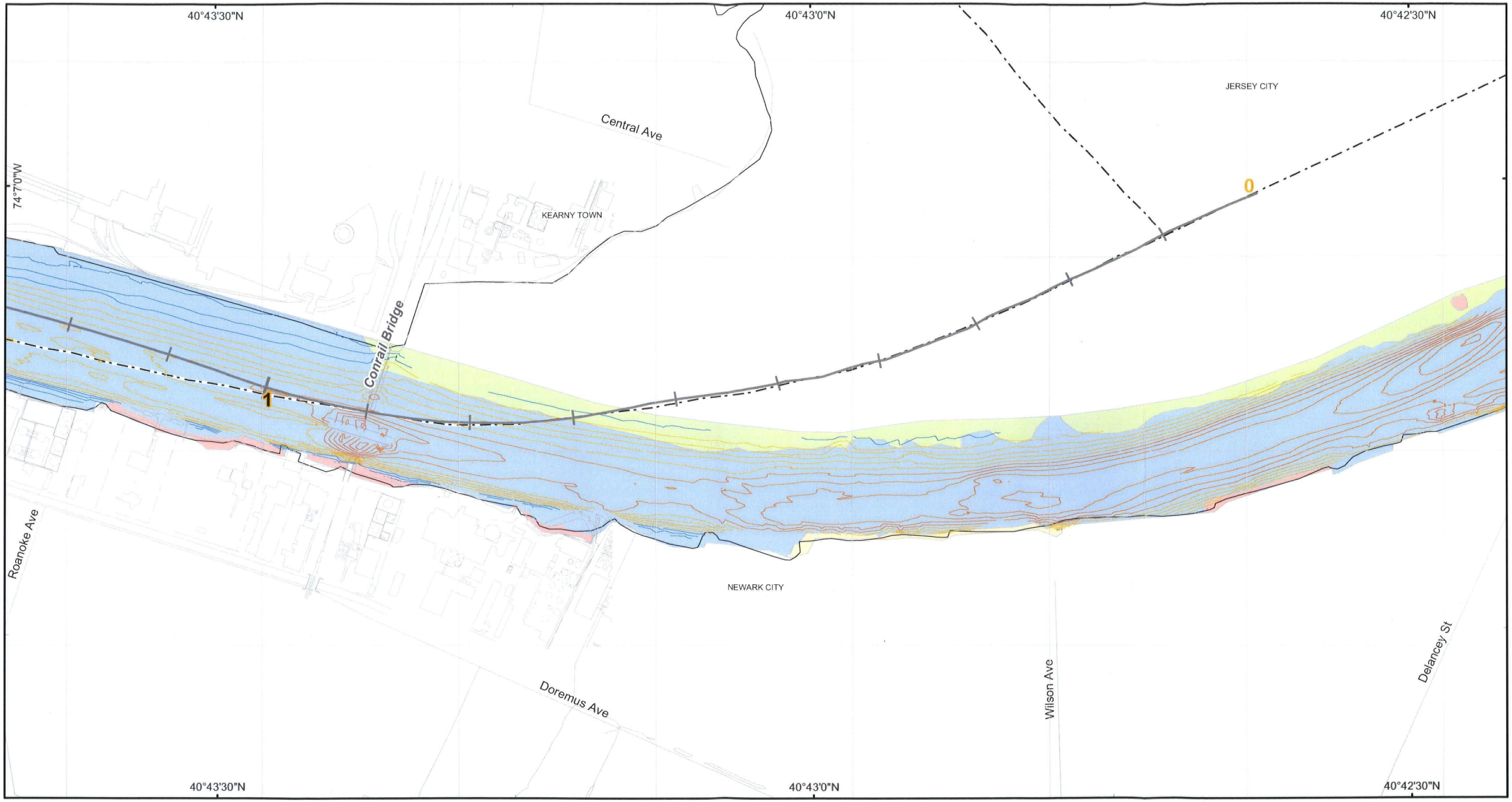
Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 17 to Dundee Dam

Surficial Sediment Texture

One-mile-per-plate map book containing (1) surficial sediment texture as interpreted by Aqua Survey, Inc. during their June 2005 geophysical survey [refer to the Draft Technical Report: Geophysical Survey (Aqua Survey, Inc., 2005) for more information] and (2) the 2004 USACE bathymetric survey displayed as elevation (feet) relative to NGVD29. Note that the sediment texture data extend to RM 16.1 and the elevation data extend to the Dundee Dam at RM 17.4.



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

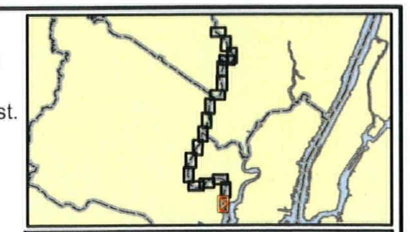
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

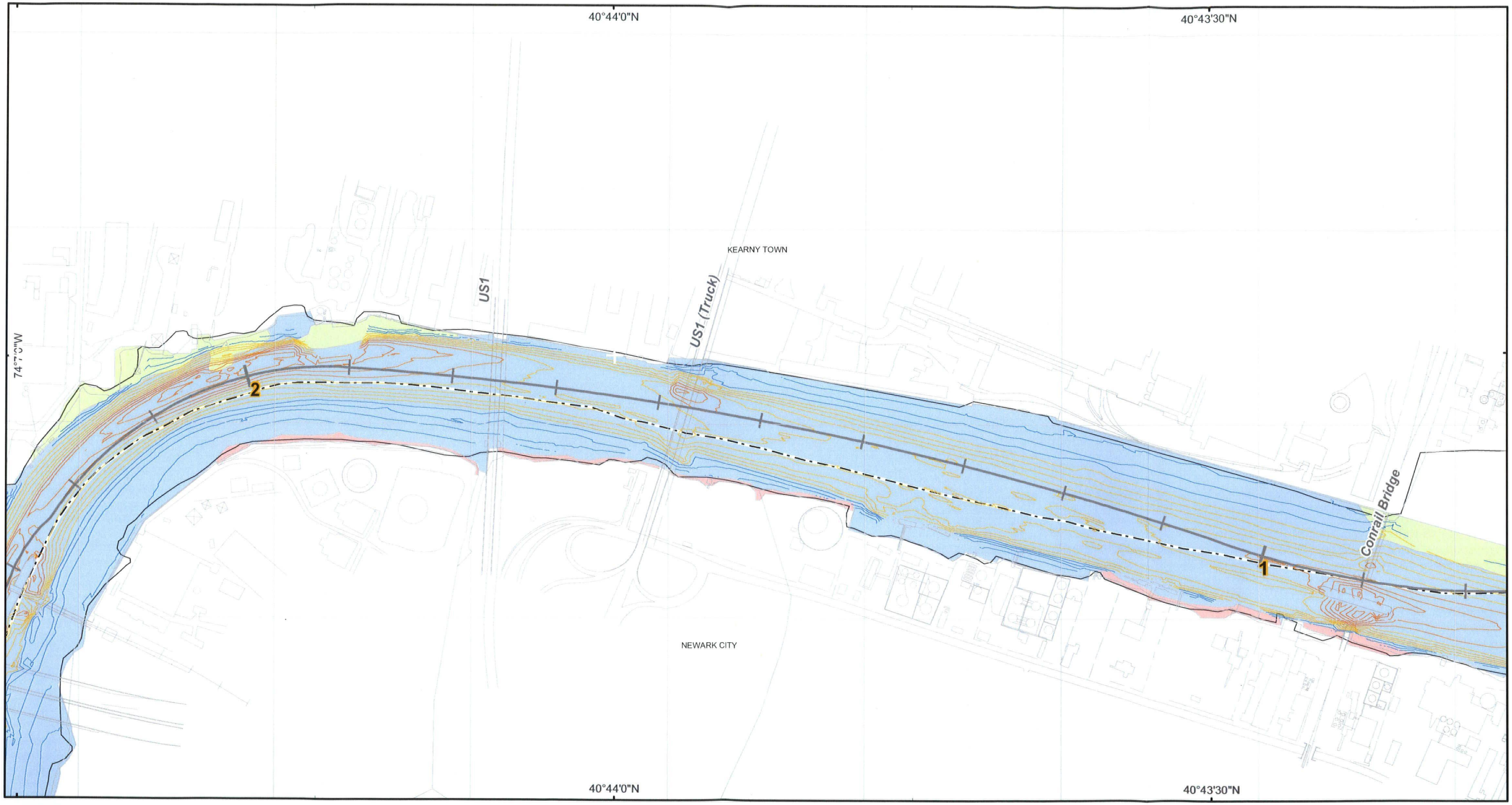
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 0 to 1

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

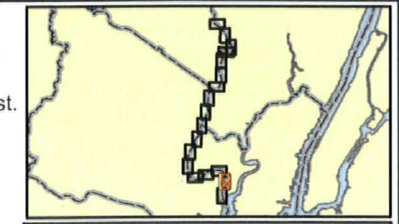
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

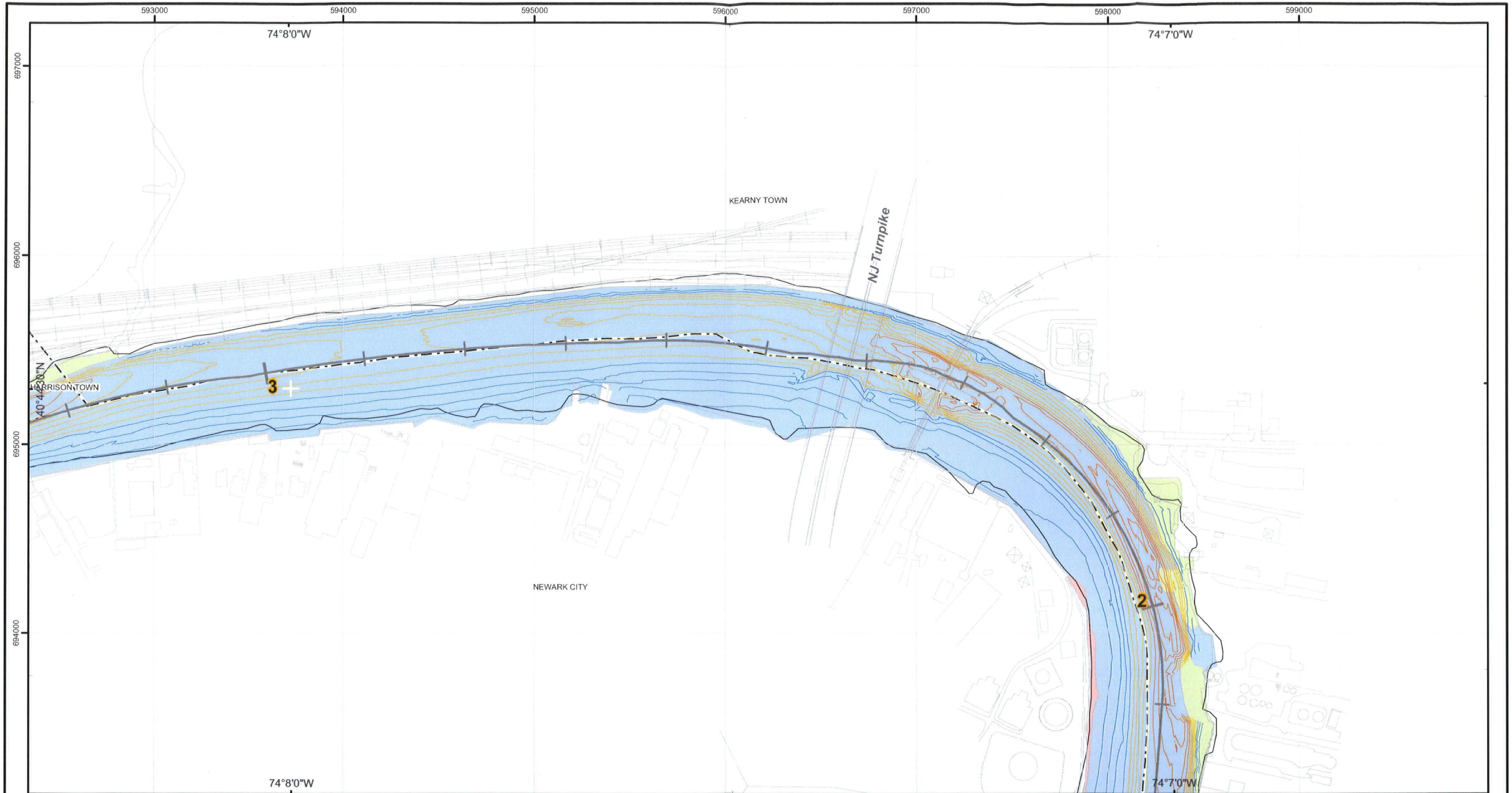
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 1 to 2

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

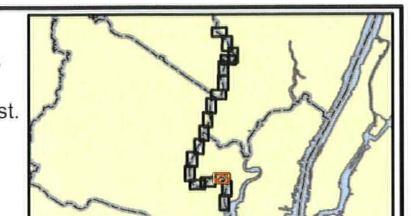
0 250 500 1,000

1 " equals 500 '

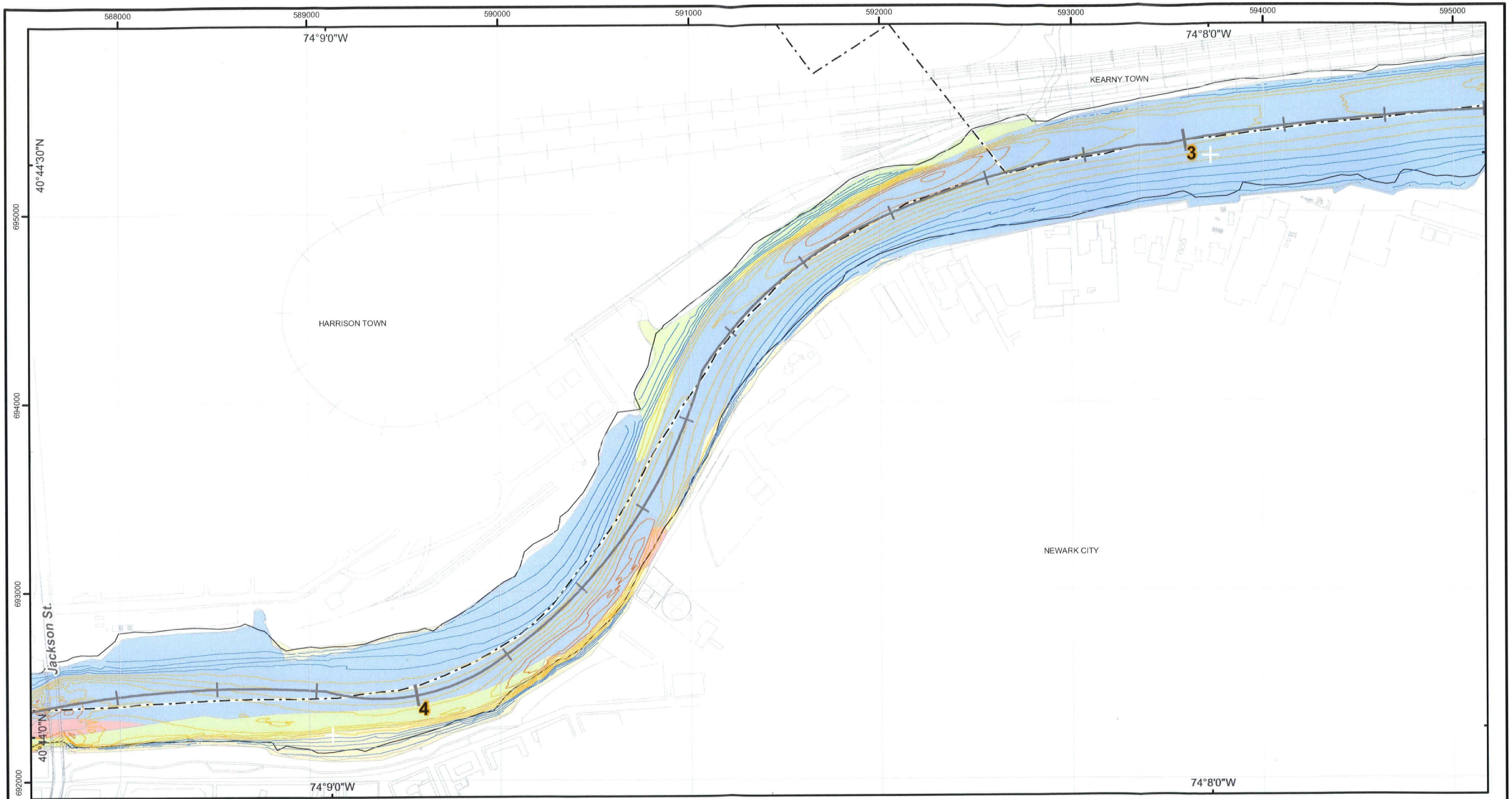
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 2 to 3



Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

US Army Corps of Engineers

MALCOLM PIRNIE

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

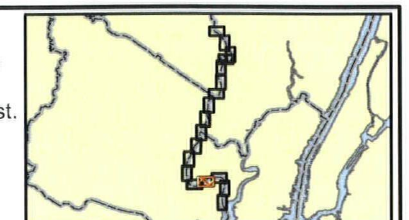
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

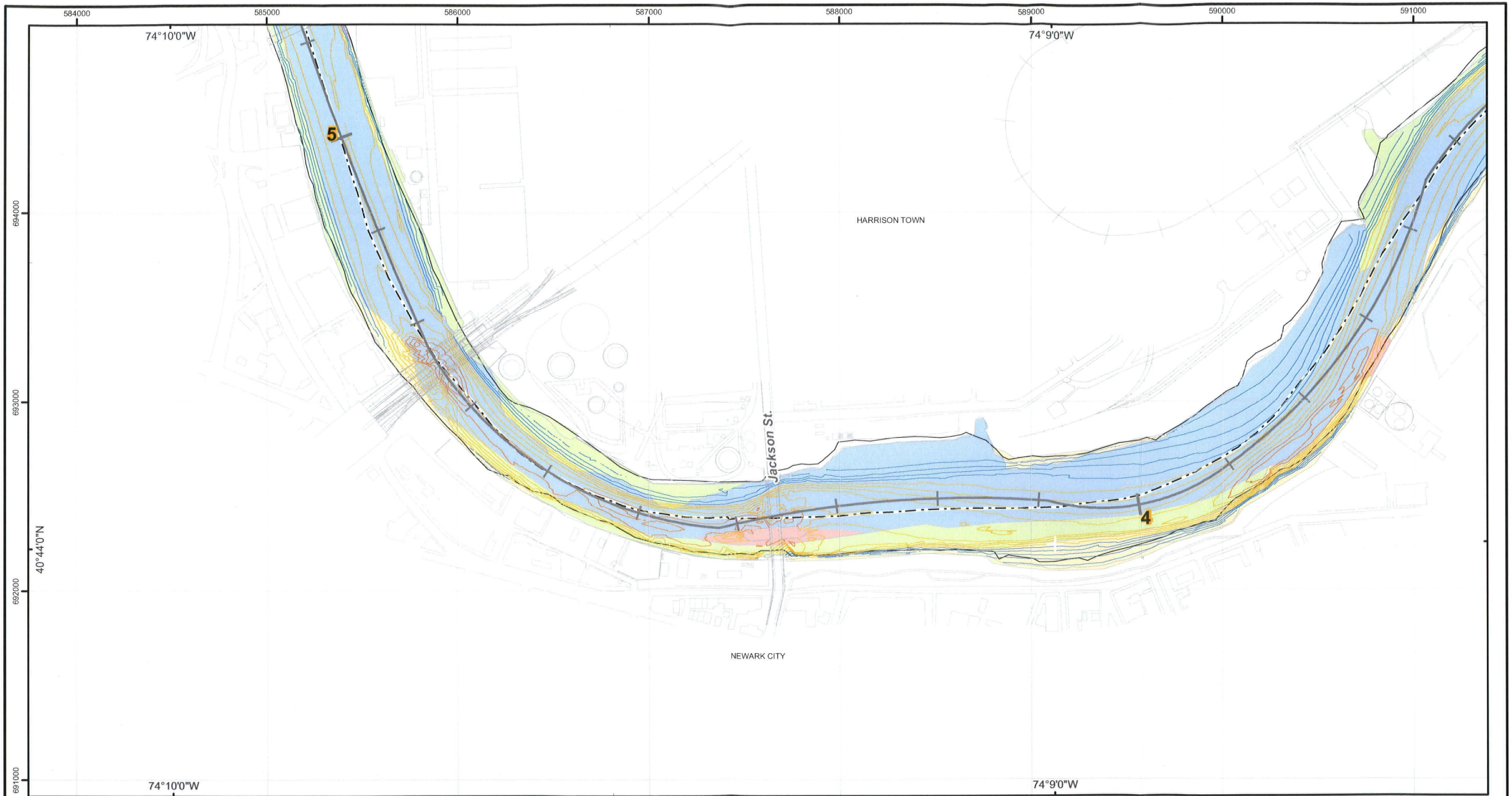
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 3 to 4

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

0 250 500 1,000

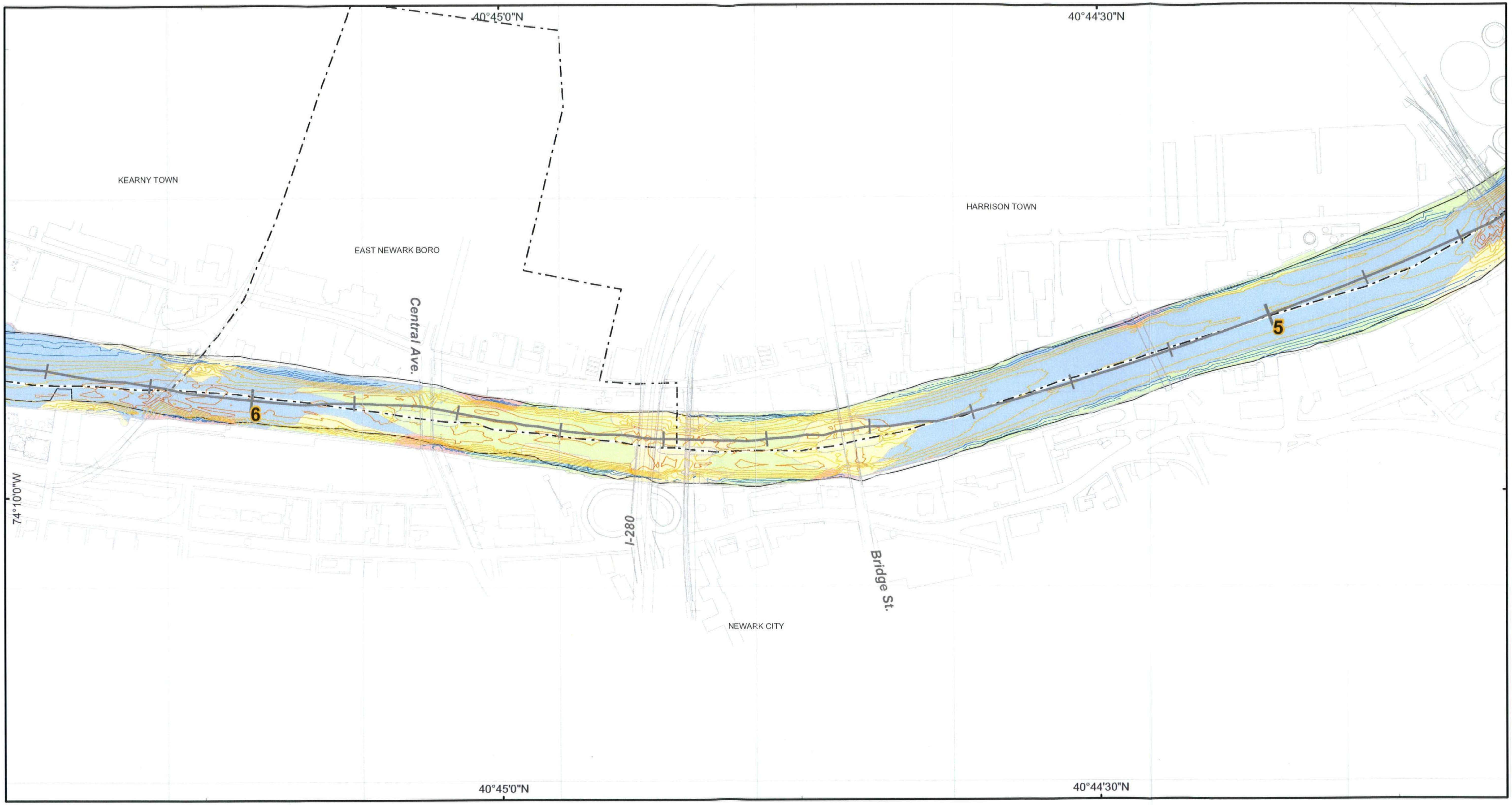
1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 4 to 5



Lower Passaic River
Restoration Project
New Jersey

US Army Corps of Engineers

MALCOLM PIRNIE

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

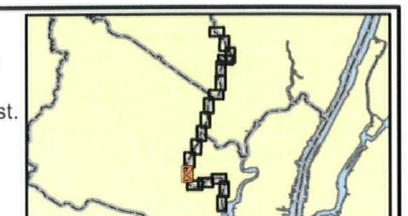
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

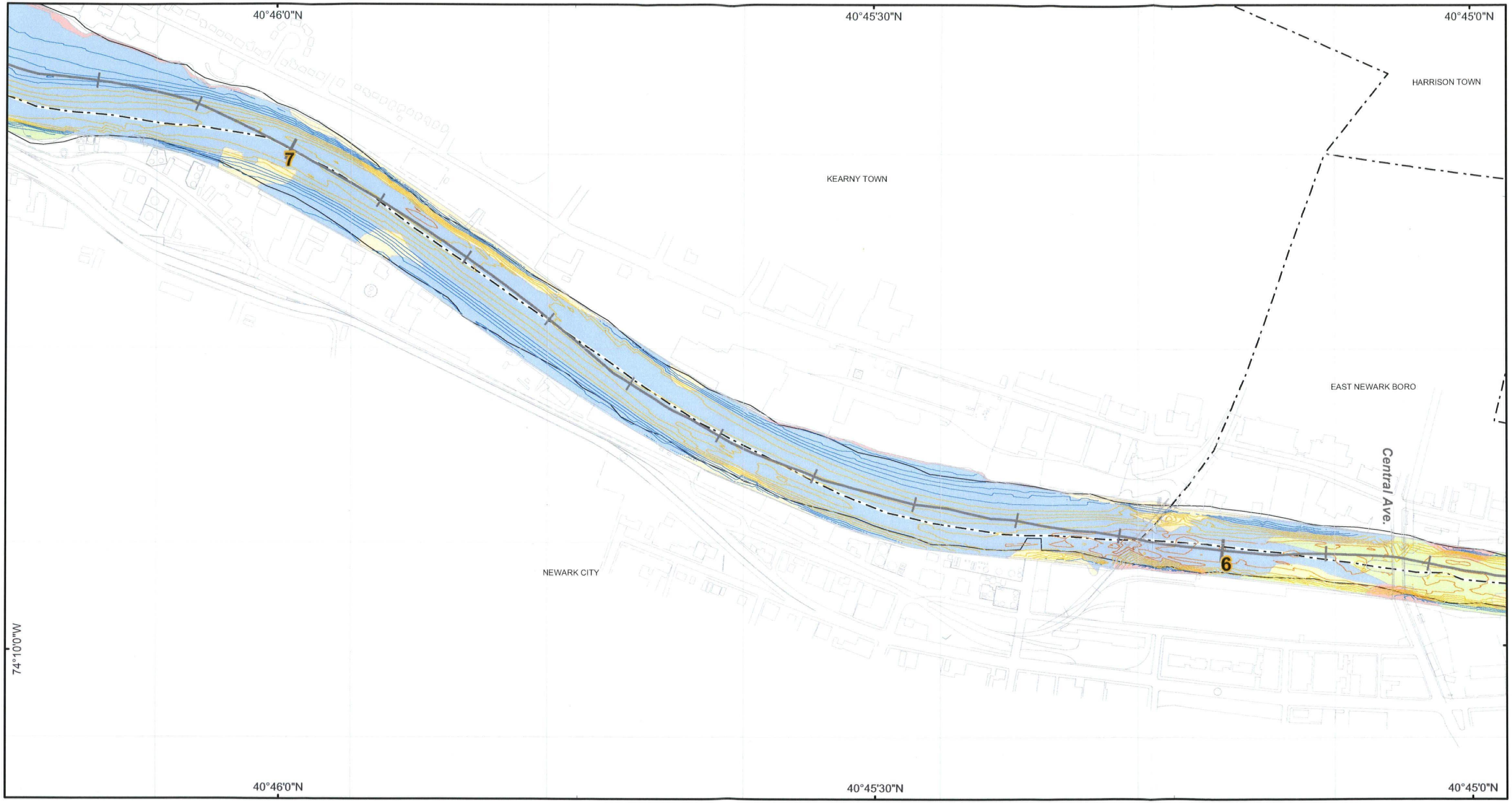
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 5 to 6

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

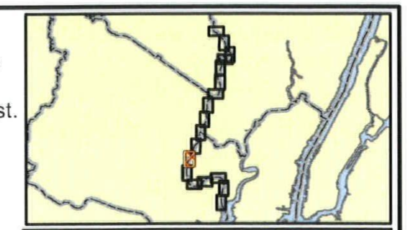
0 250 500 1,000

1 " equals 500 '

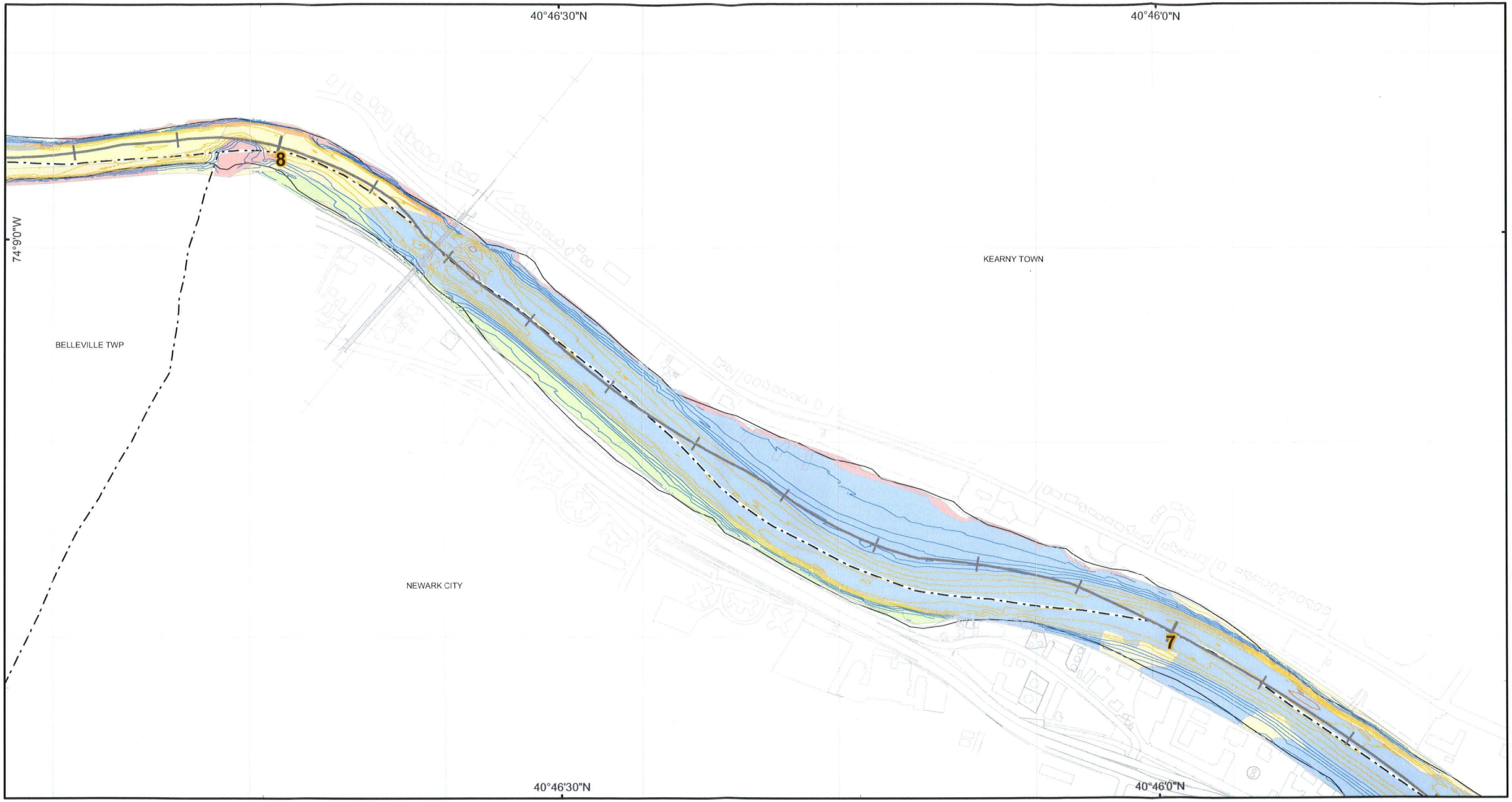
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 6 to 7



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

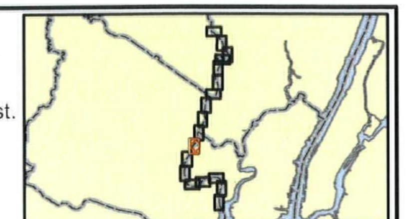
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

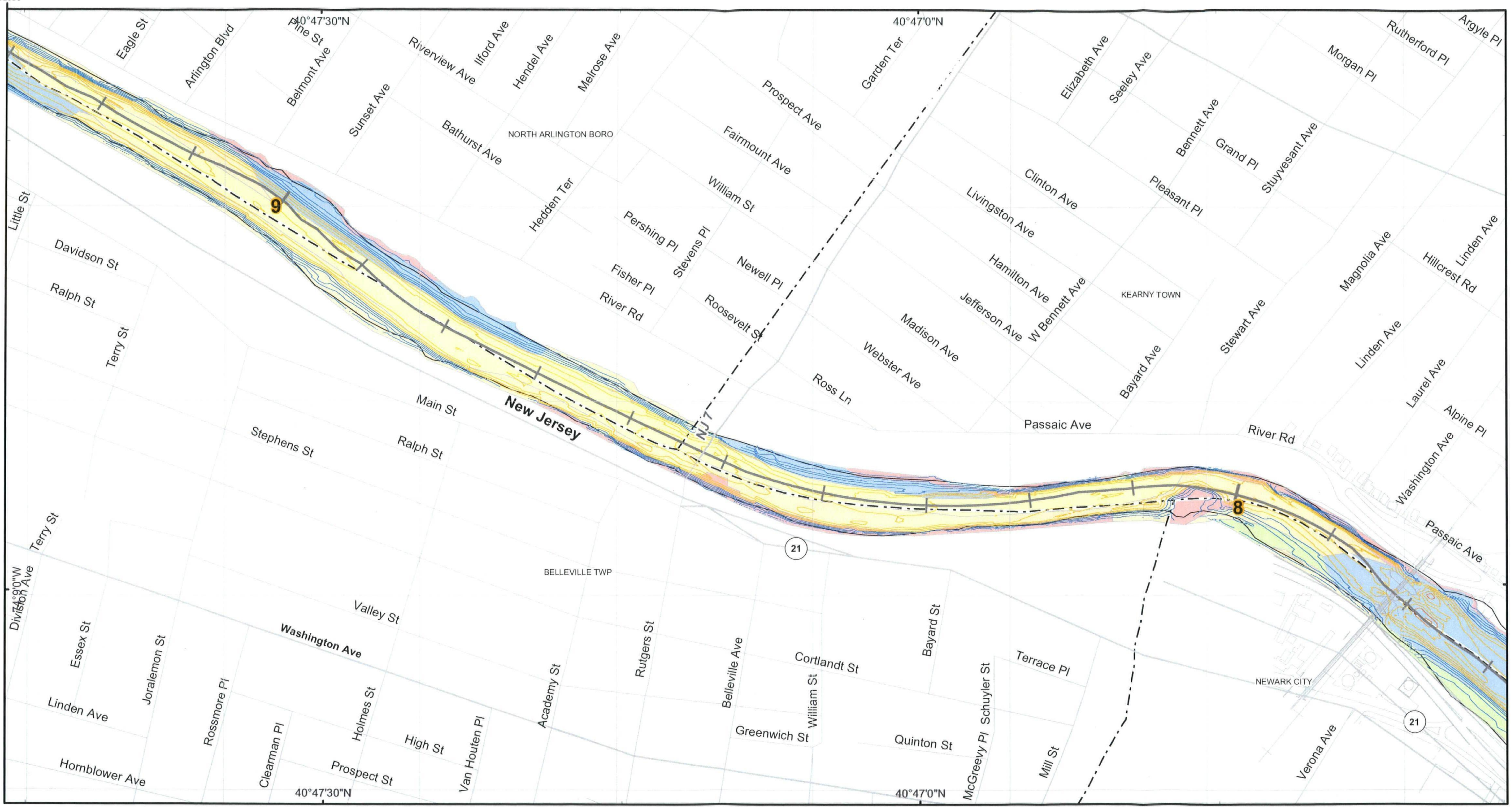
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 7 to 8

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

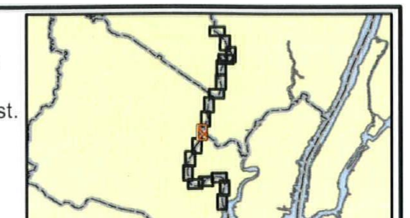
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

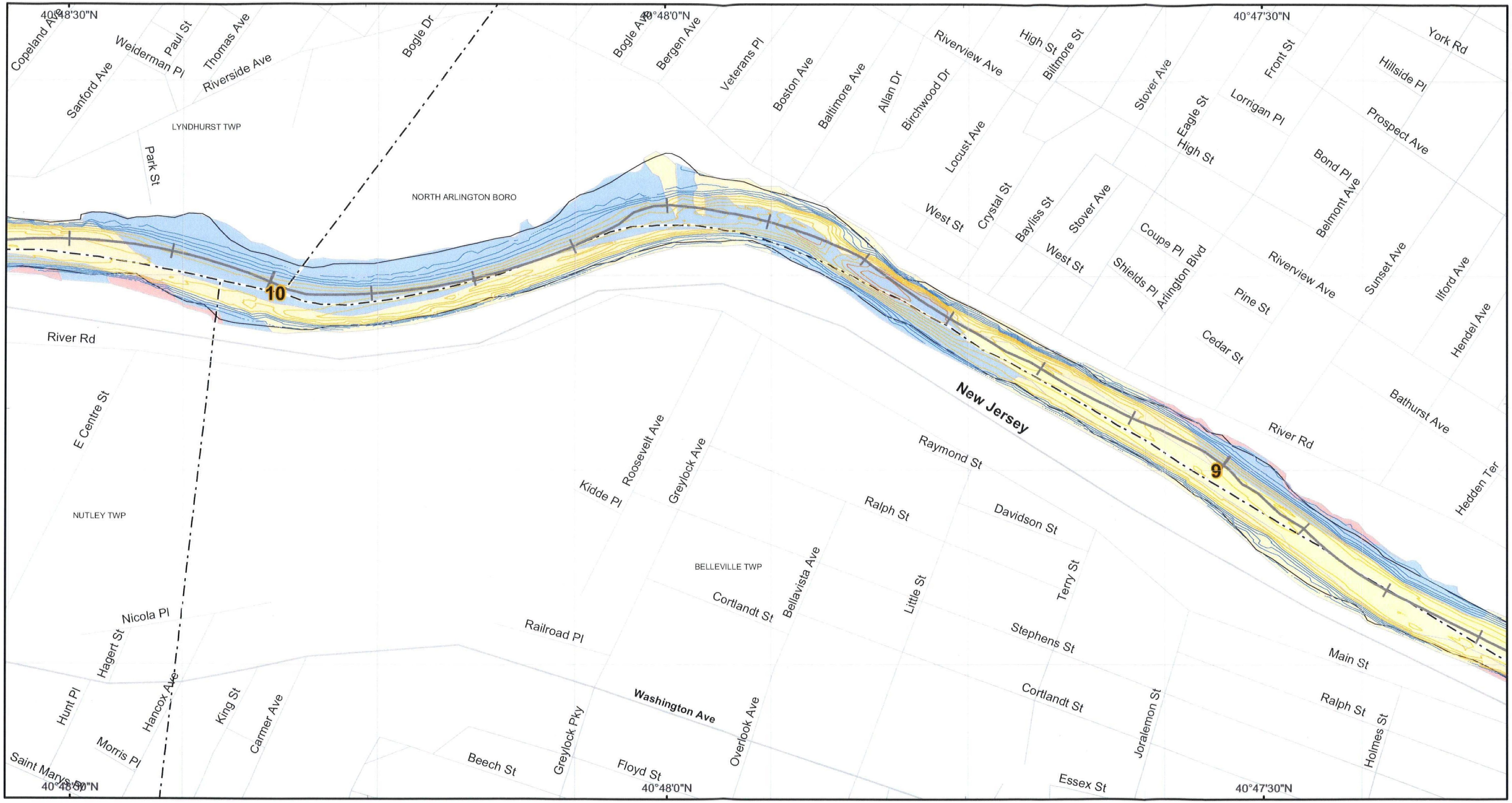
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 8 to 9

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

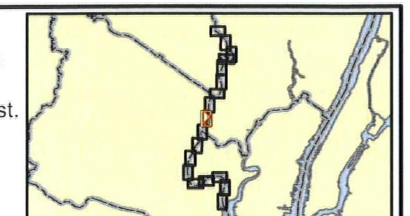
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

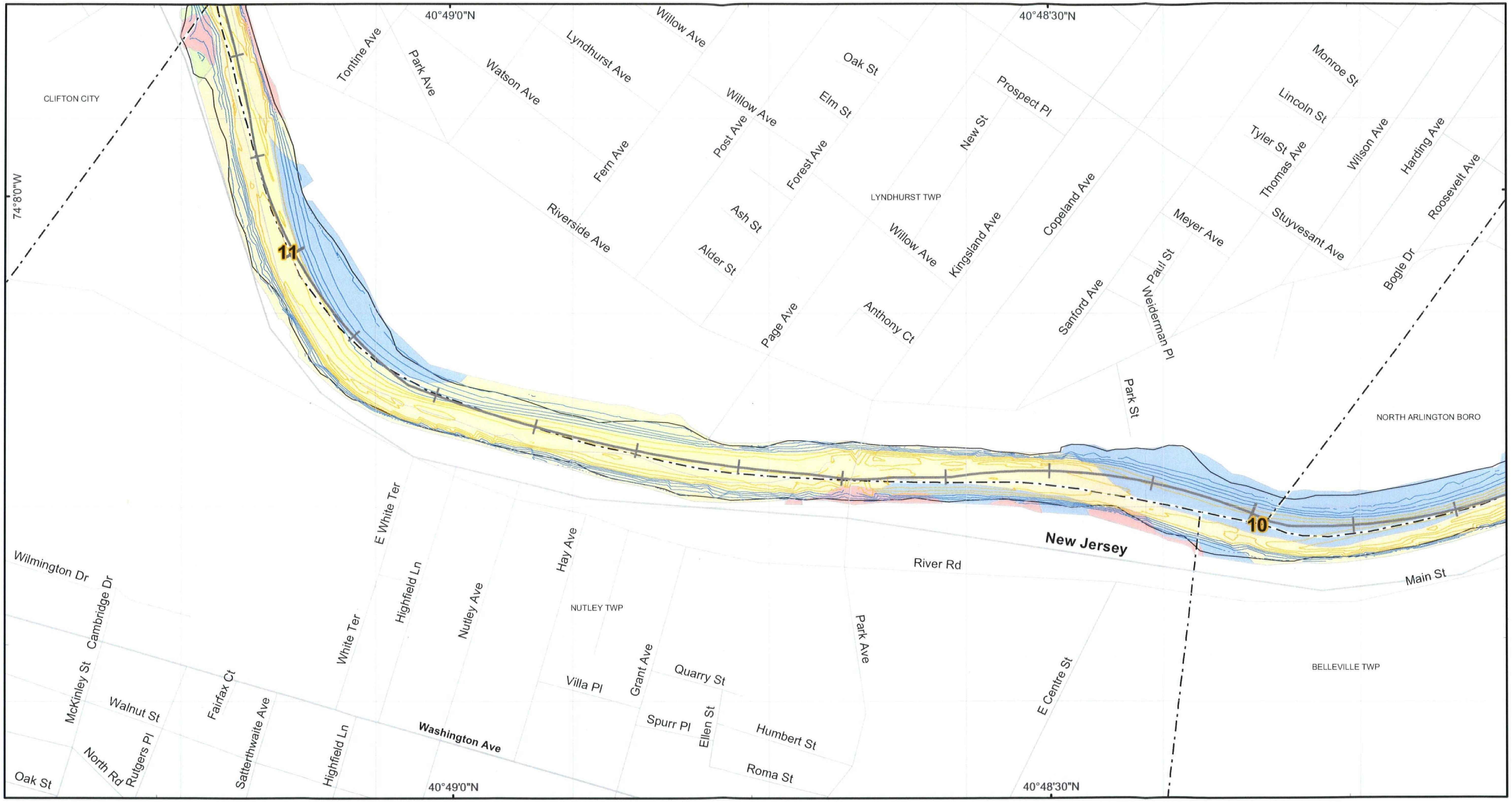
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 9 to 10

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

0 250 500 1,000

1 " equals 500 '

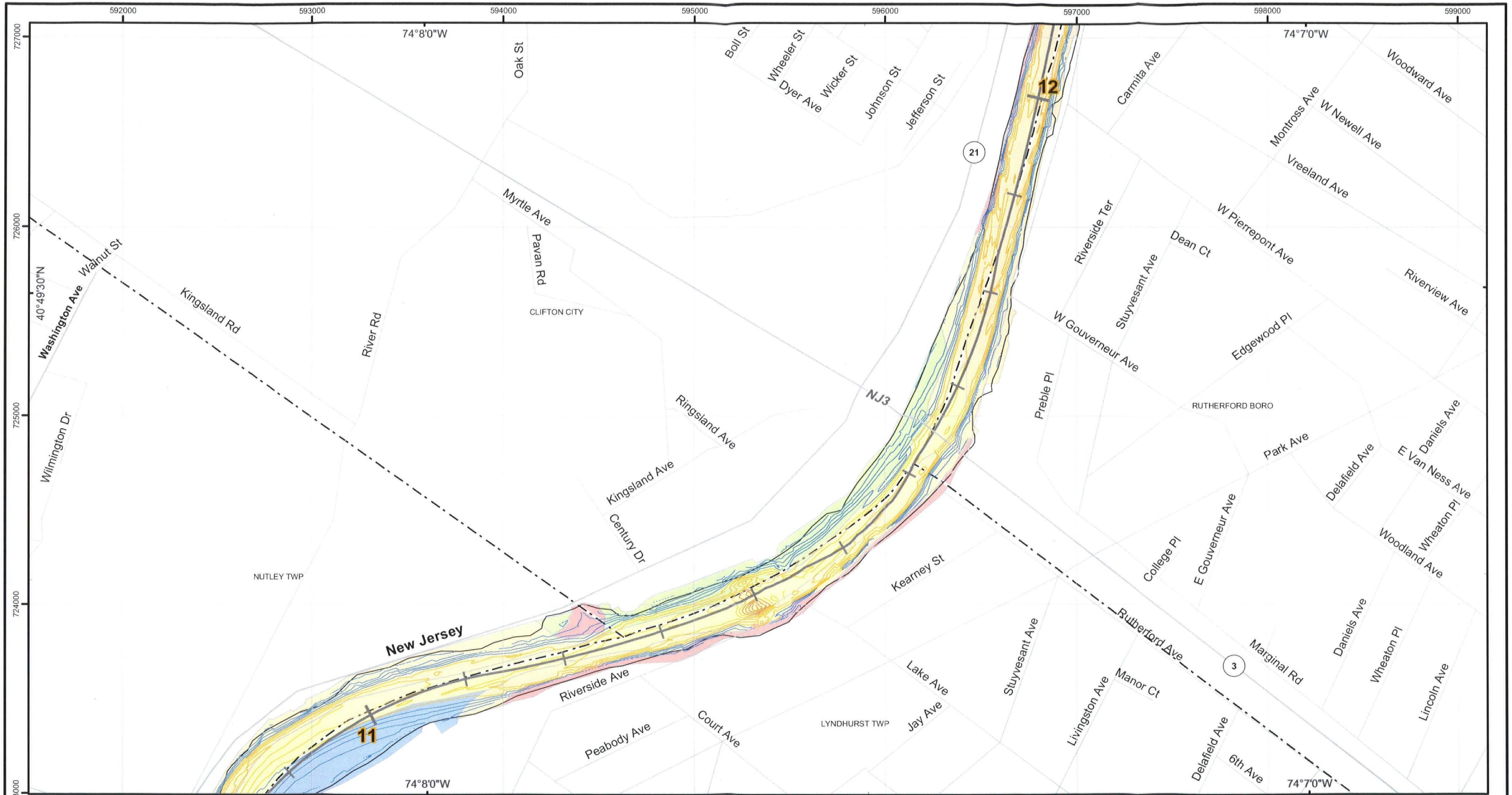
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 10 to 11

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

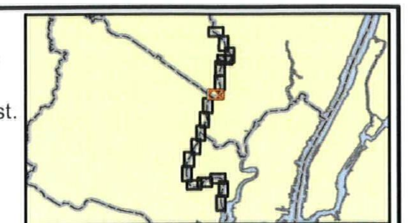
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

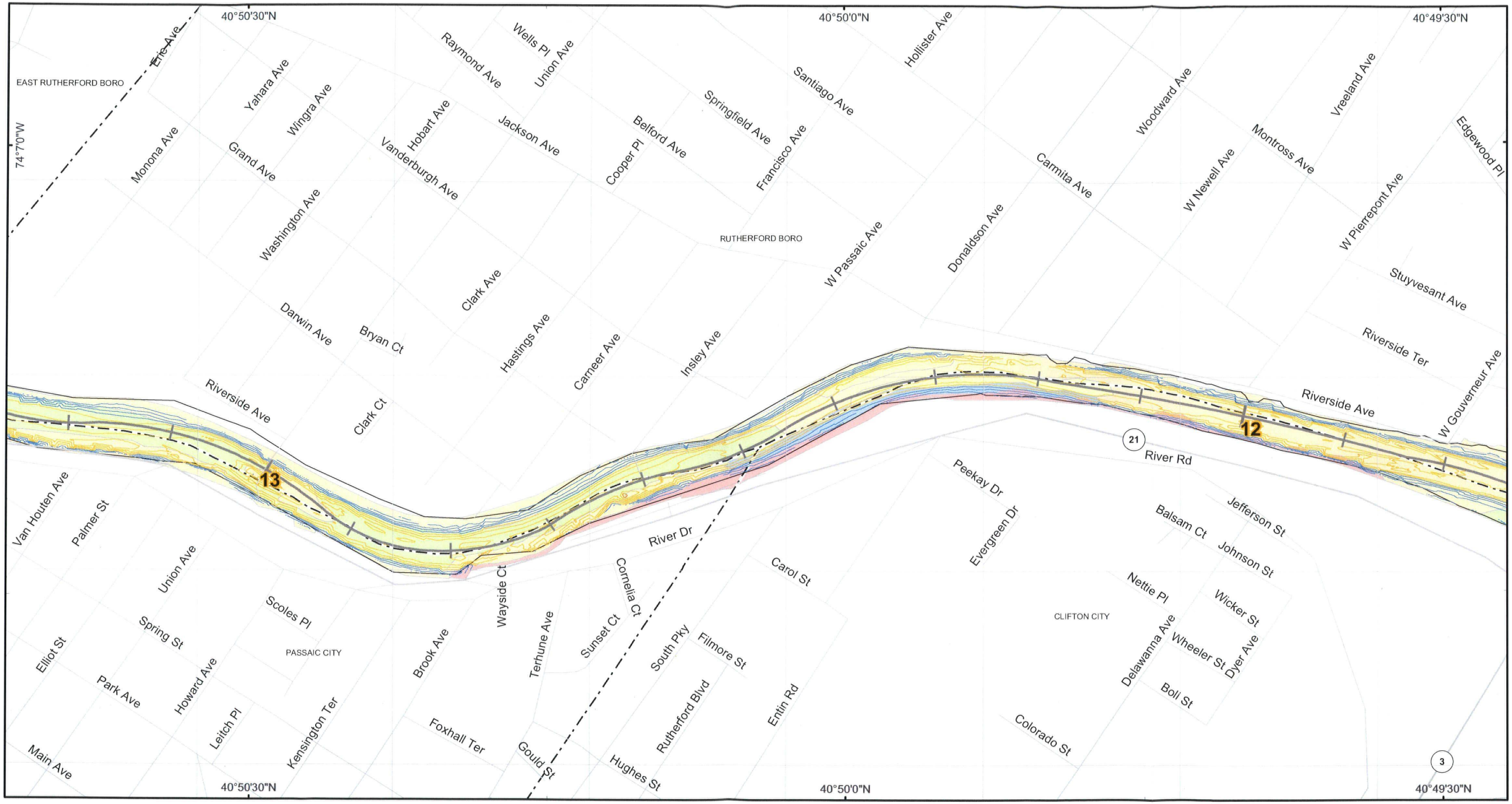
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 11 to 12

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

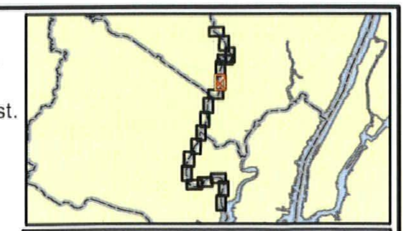
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 12 to 13

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

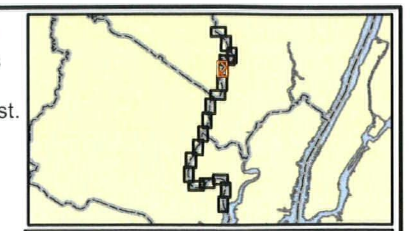
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 13 to 14

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

US Army Corps of Engineers

MALCOLM PIRNIE

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

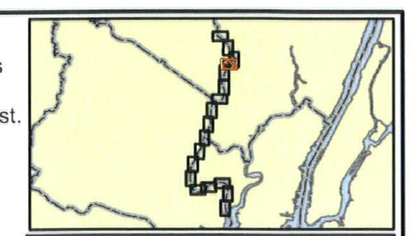
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 14 to 15

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

-30 to -20
-18 to -10
-8 to 0
2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

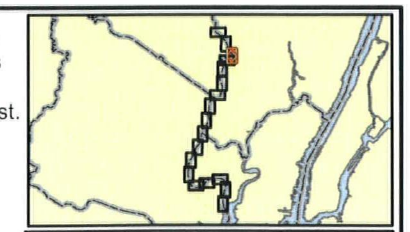
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

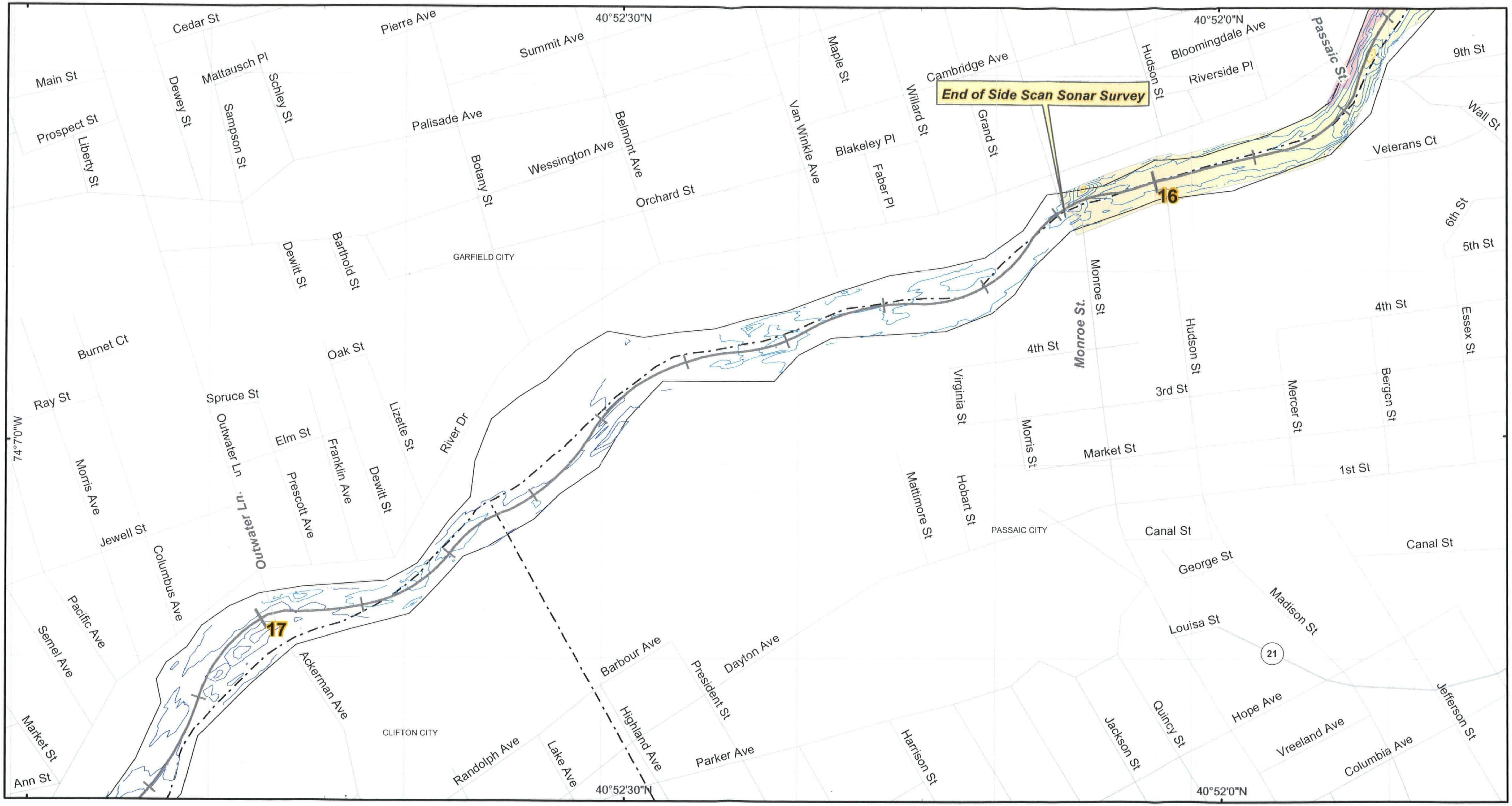
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 15 to 16

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

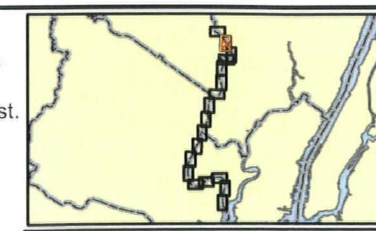
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

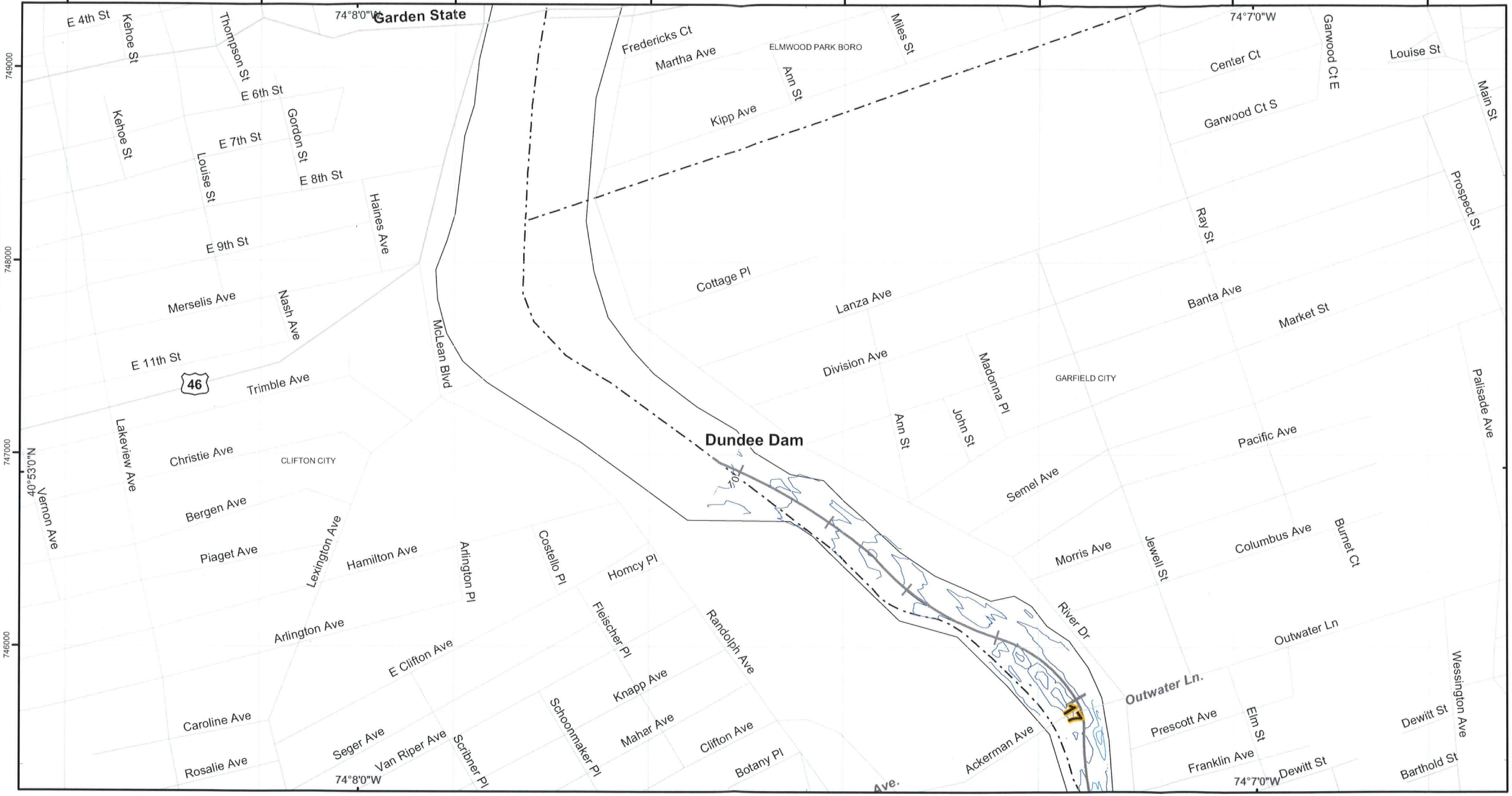
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 16 to 17

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
10/31/2005 -- 4:45:20 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Texture Map

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

N

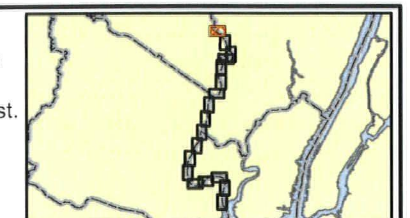
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

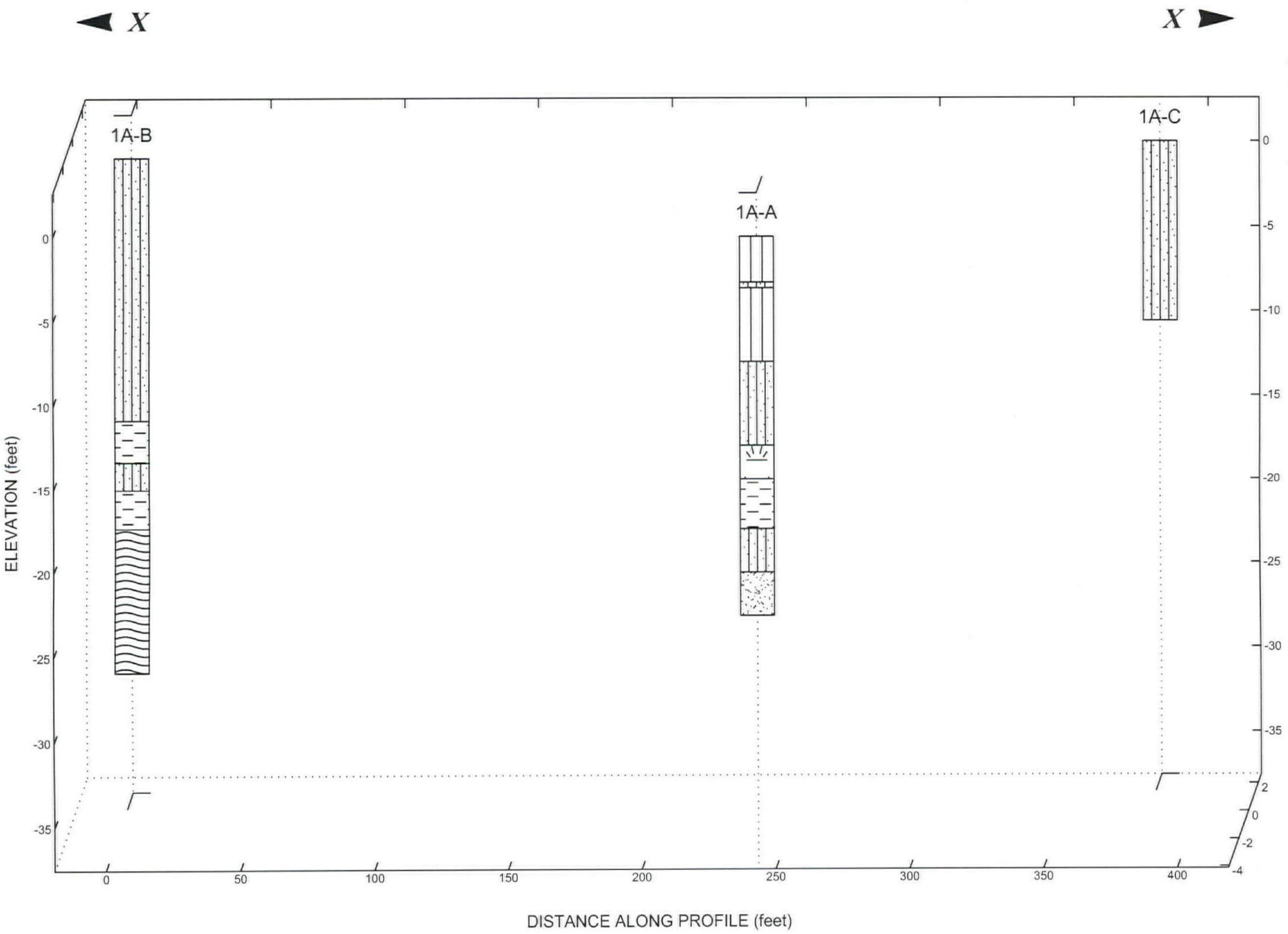
Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 17 to Dundee Dam

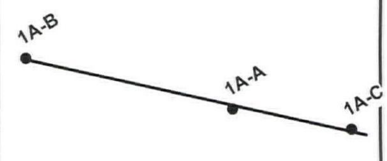
Fence Diagrams

Fence diagrams displaying sub-bottom geological units from geotechnical borings collected during the June 2005 geophysical survey and classified by Malcolm Pirnie, Inc. using the United Soil Classification System (USCS) [refer to the Draft Technical Report: Geophysical Survey (Aqua Survey, Inc., 2005) for more information]. Note that the fence diagrams extend to RM 16.



Lithology Graphics

- Silt
- Sandy Silt
- Silty Sand or Silt and Sand
- Peat
- Low plasticity clay
- Fine to Medium Sand
- High plasticity clay



Site Map Scale 1 inch equals 220 feet

Explanation

1A-A — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 63

Horizontal Scale (feet)

Vertical Exaggeration: 6.5x

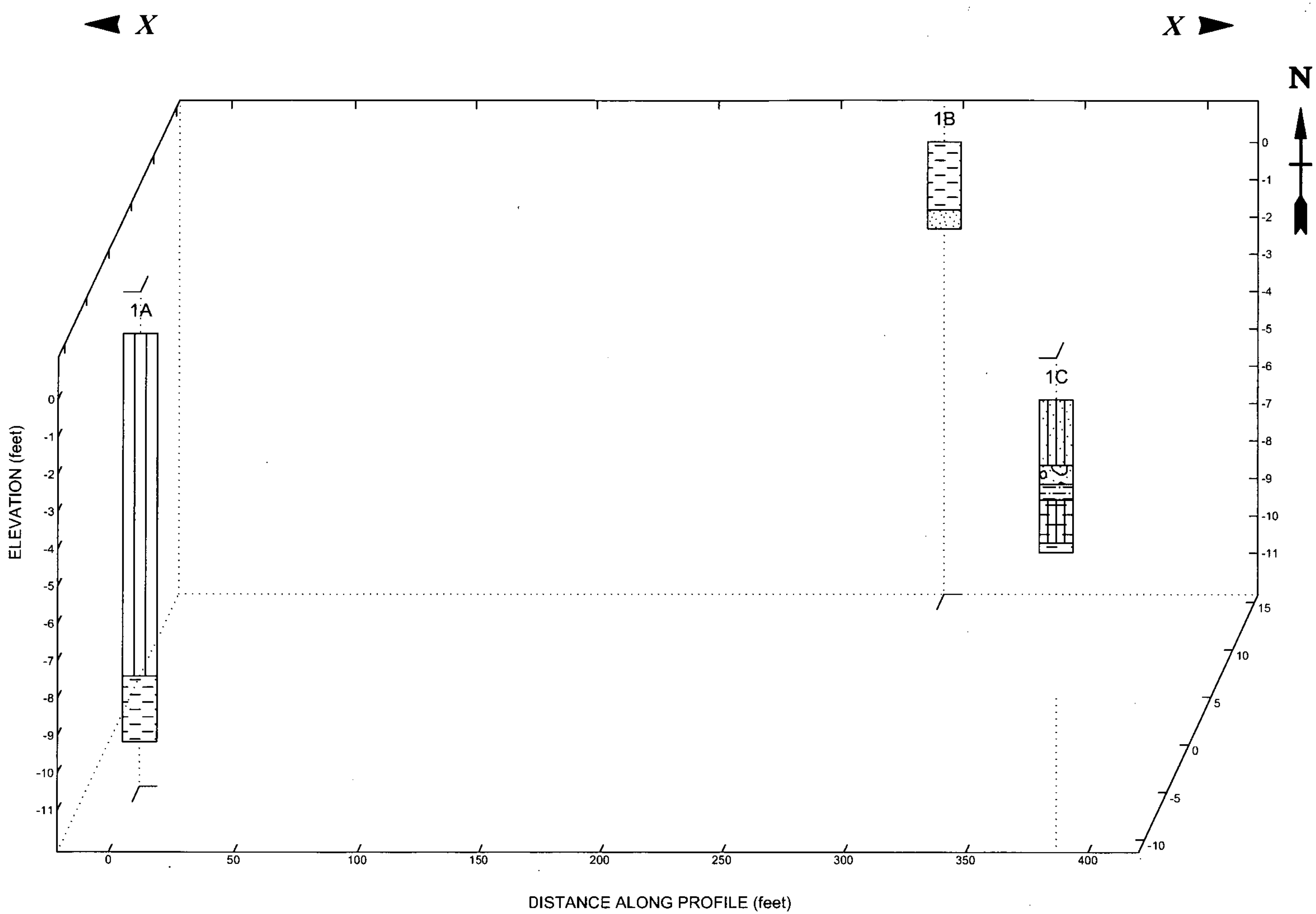
Malcolm Pirnie, Inc.

Location : Mile 0

MALCOLM PIRNIE

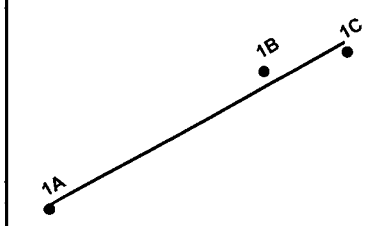
Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	1A-A - 1A-C



Lithology Graphics

- Silt
- Low plasticity clay
- Fine Sand
- Silty Sand or Silt and Sand
- Gravelly Sand
- Sandy Clay.
- Silty Clay



Site Map Scale 1 inch equals 220 feet

Explanation

1A — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 69

Horizontal Scale (feet)

Vertical Exaggeration: 15.5x

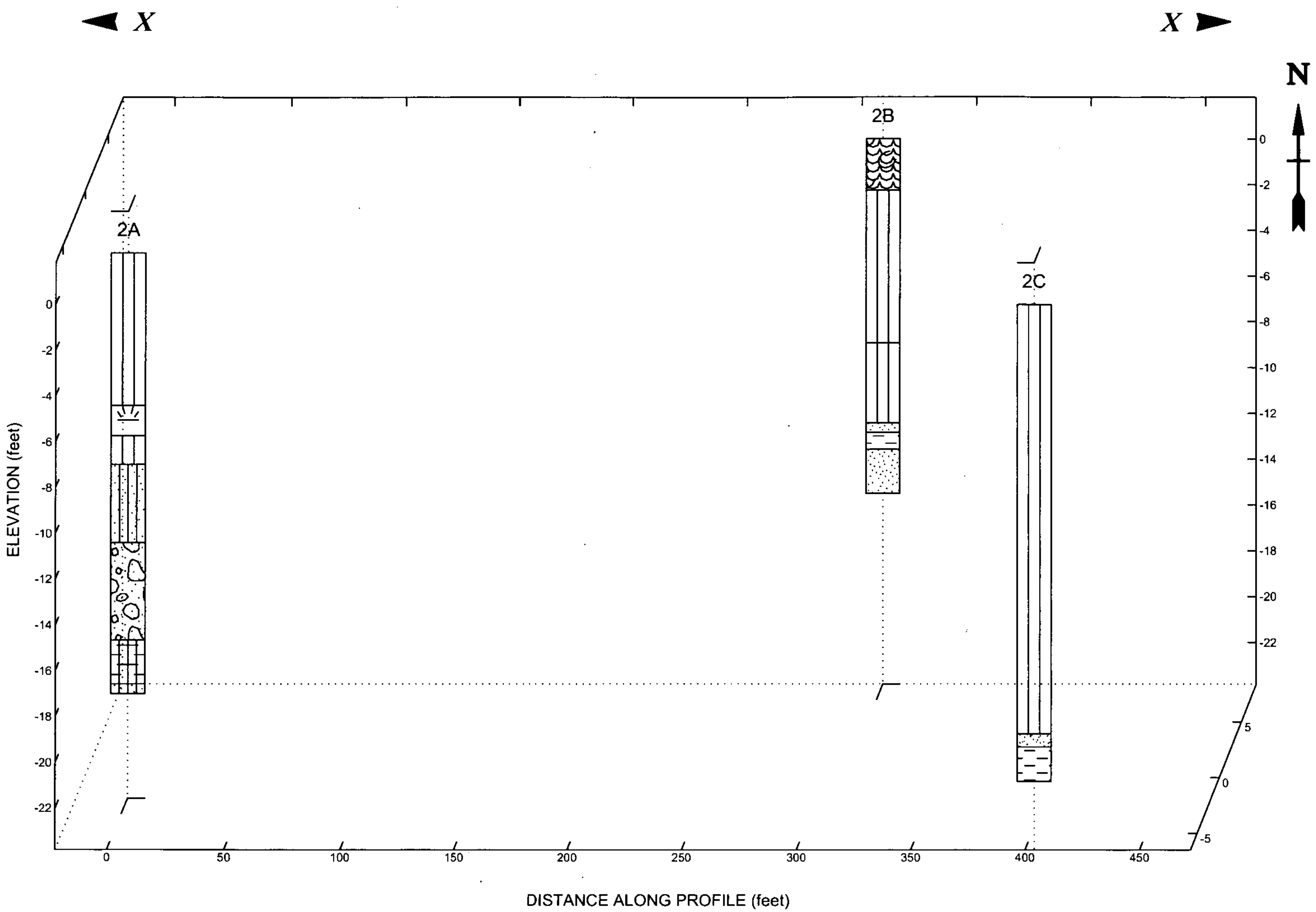
Malcolm Pirnie, Inc.

Location : Mile 1

MALCOLM PIRNIE

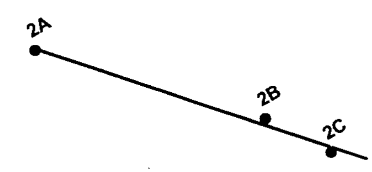
Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	1A - 1C



Lithology Graphics

- Silt
- Peat
- Silty Sand or Silt and Sand
- Gravelly Sand
- Silty Clay
- Organic silt or clay with shells
- Fine Sand
- Low plasticity clay
- Fine to Medium Sand



Site Map Scale 1 inch equals 250 feet

Explanation

2A — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 74

Horizontal Scale (feet)

Vertical Exaggeration: 10x

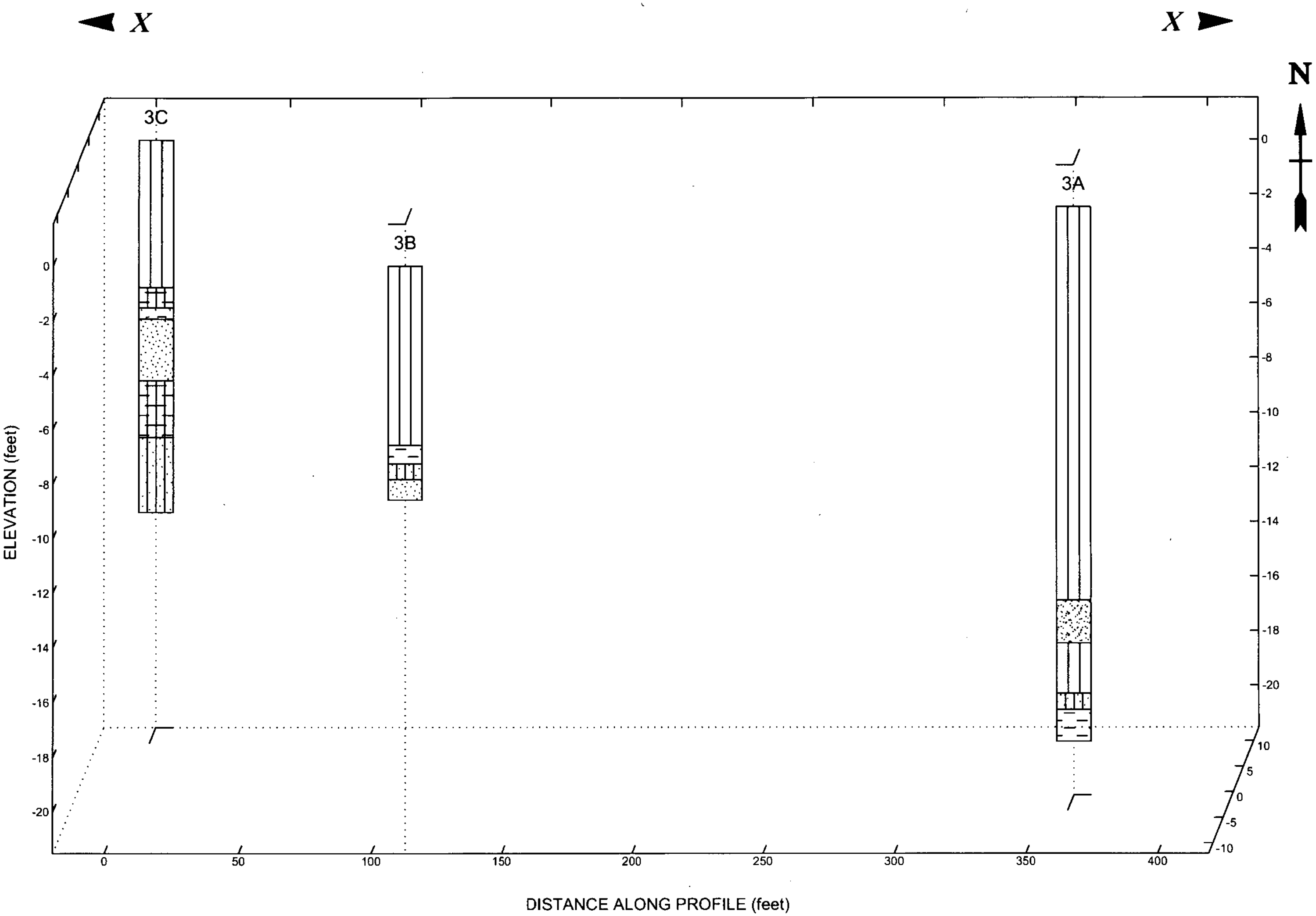
Malcolm Pirnie, Inc.

Location : Mile 2

MALCOLM PIRNIE

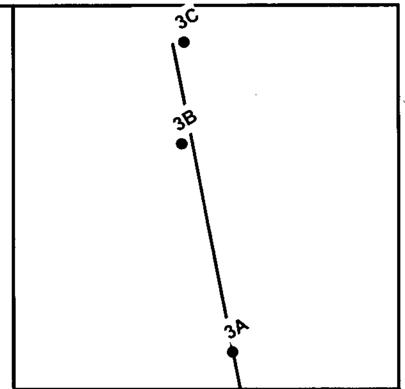
Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	2A - 2C



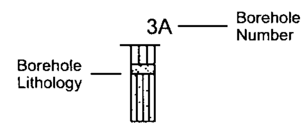
Lithology Graphics

- Silt
- Fine Sand
- Medium Sand
- Silty Clay
- Silty Sand or Silt and Sand
- Clayey Sand or Sand and Clay
- Low plasticity clay



Site Map Scale 1 inch equals 220 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 64

Horizontal Scale (feet)

Vertical Exaggeration: 10.5x

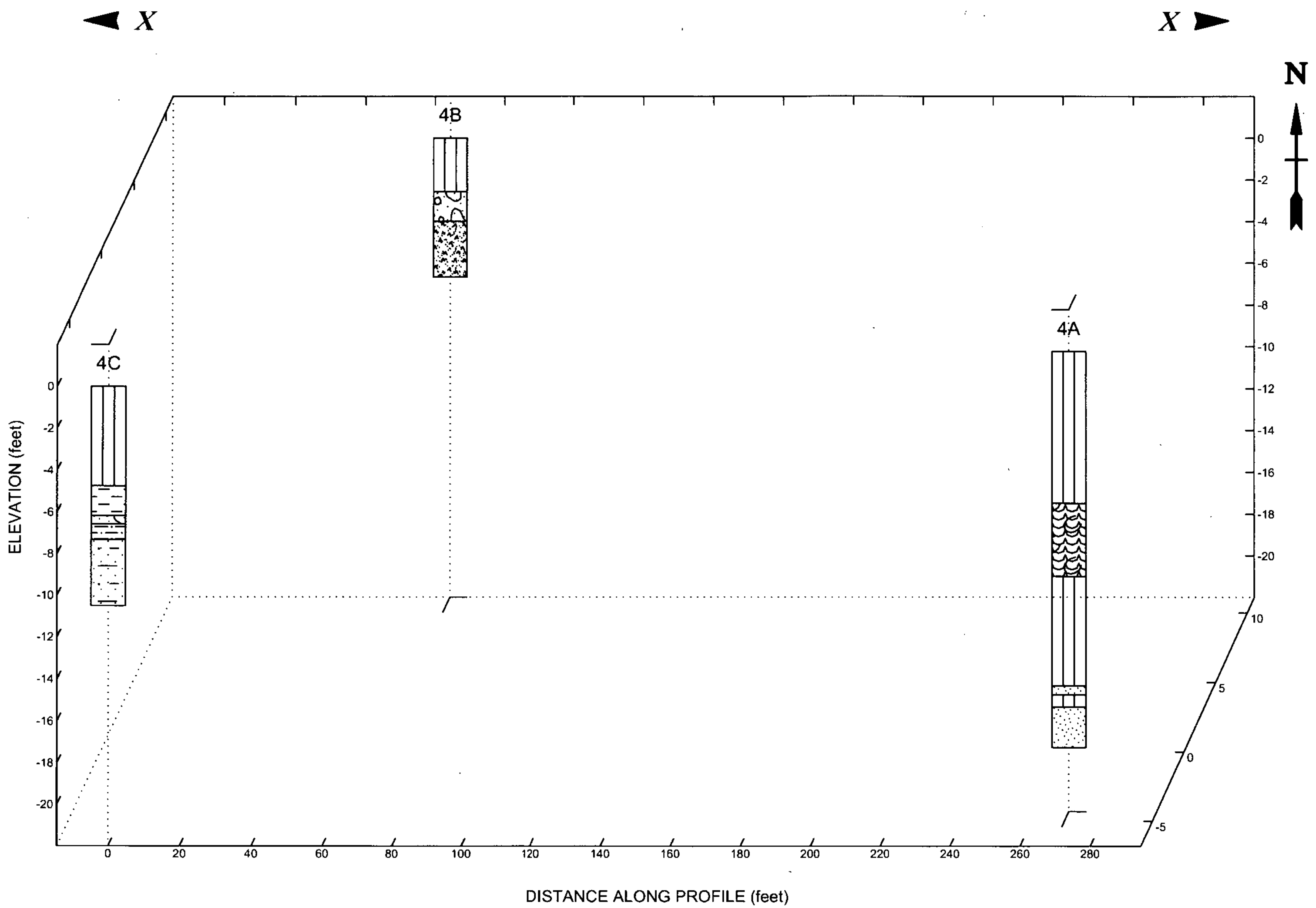
Malcolm Pirnie, Inc.

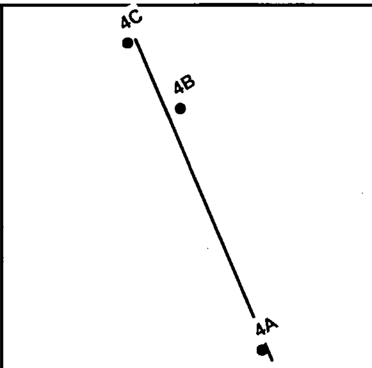
Location: Mile 3

MALCOLM PIRNIE

Lower Passaic River
New Jersey

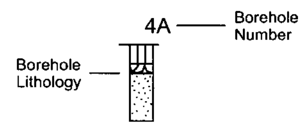
JOB NUMBER	TRANSECT NUMBER
3473007	3A-3C





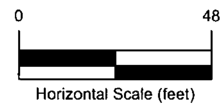
Site Map Scale 1 inch equals 155 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.



Vertical Exaggeration: 6x

Lithology Graphics

- Silt
- Medium - Coarse Sand
- Clayey Sand or Sand and Clay
- Organic silt or clay with shells
- Low plasticity clay
- Fine Sand
- Sandy Gravel
- Gravelly Sand
- Sandy Clay.

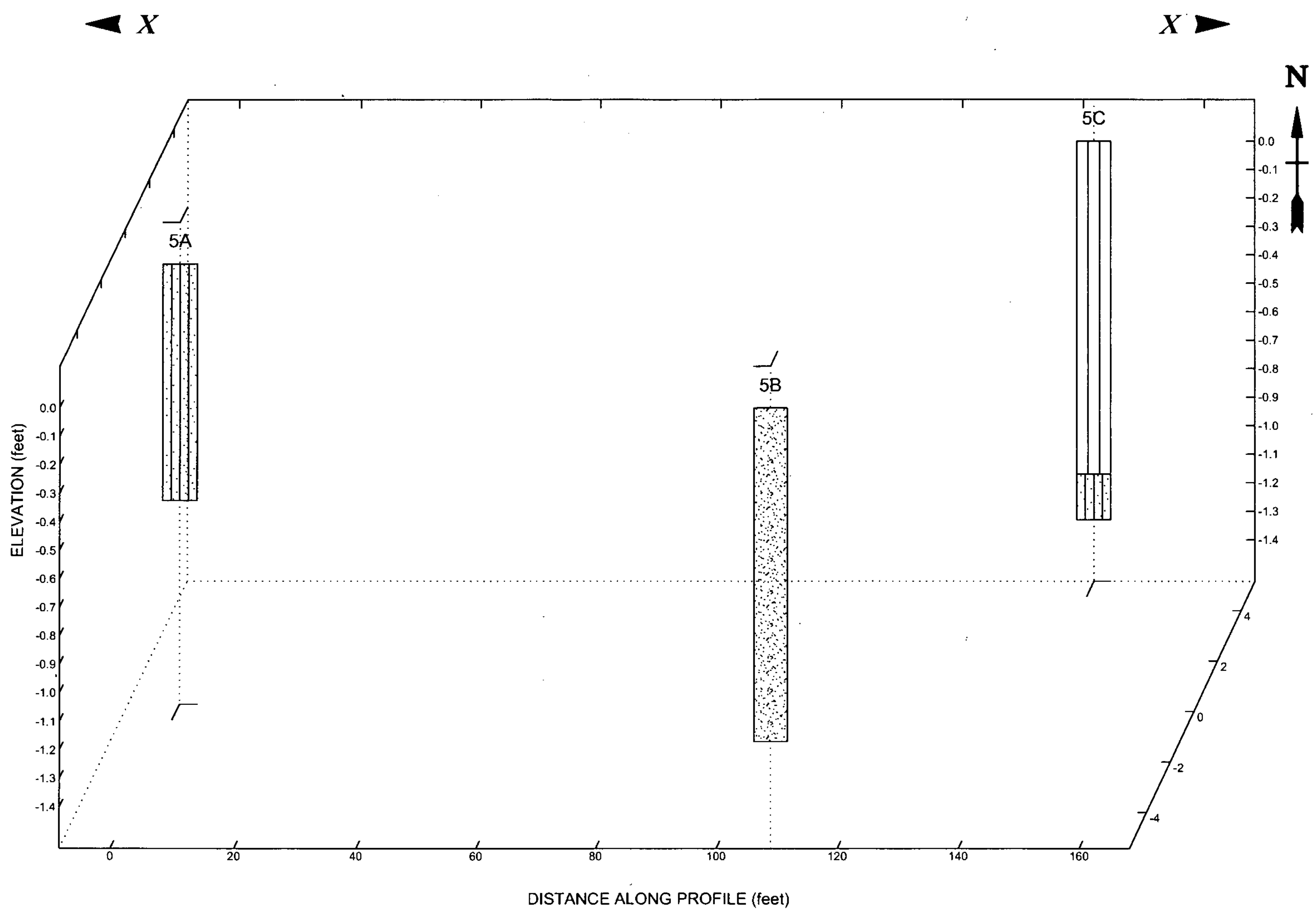
Malcolm Pirnie, Inc.

Location : Mile 4

MALCOLM PIRNIE

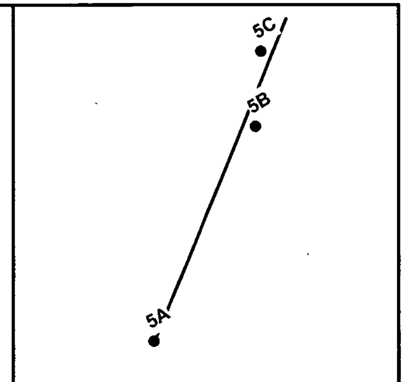
Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	4A - 4C



Lithology Graphics

Sandy Silt | Fine to Medium Sand | Silt | Silty Sand or Silt and Sand



Site Map Scale 1 inch equals 90 feet

Explanation

5A — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 28

Horizontal Scale (feet)

Vertical Exaggeration: 47.5x

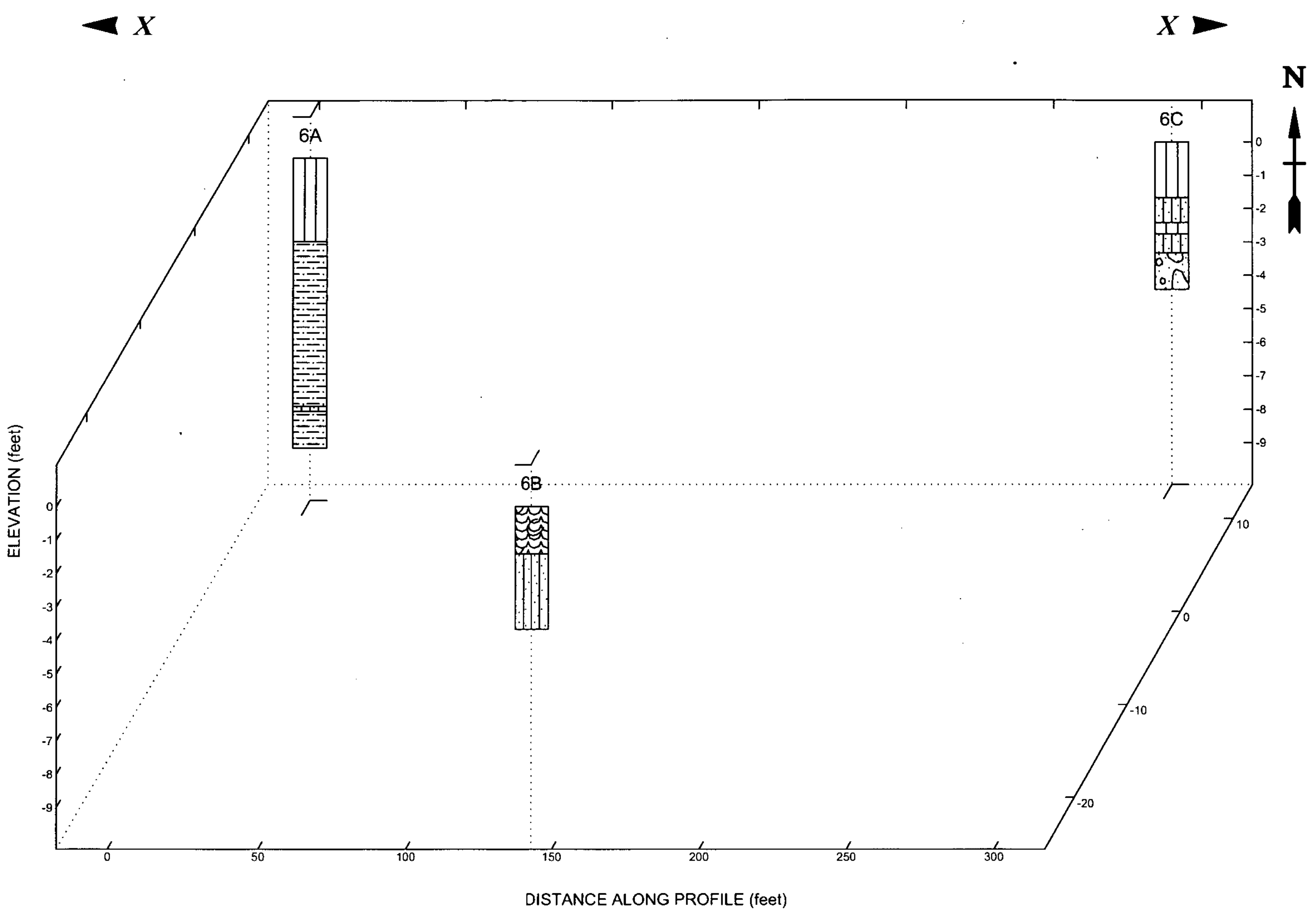
Malcolm Pirnie, Inc.

Location : Mile 5

MALCOLM PIRNIE

Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	5A - 5C



Lithology Graphics

- Silt
- Sandy Clay.
- Sandy Silt
- Organic silt or clay with shells
- Gravelly Sand

Explanation

6A — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 57

Horizontal Scale (feet)

Vertical Exaggeration: 11.5x

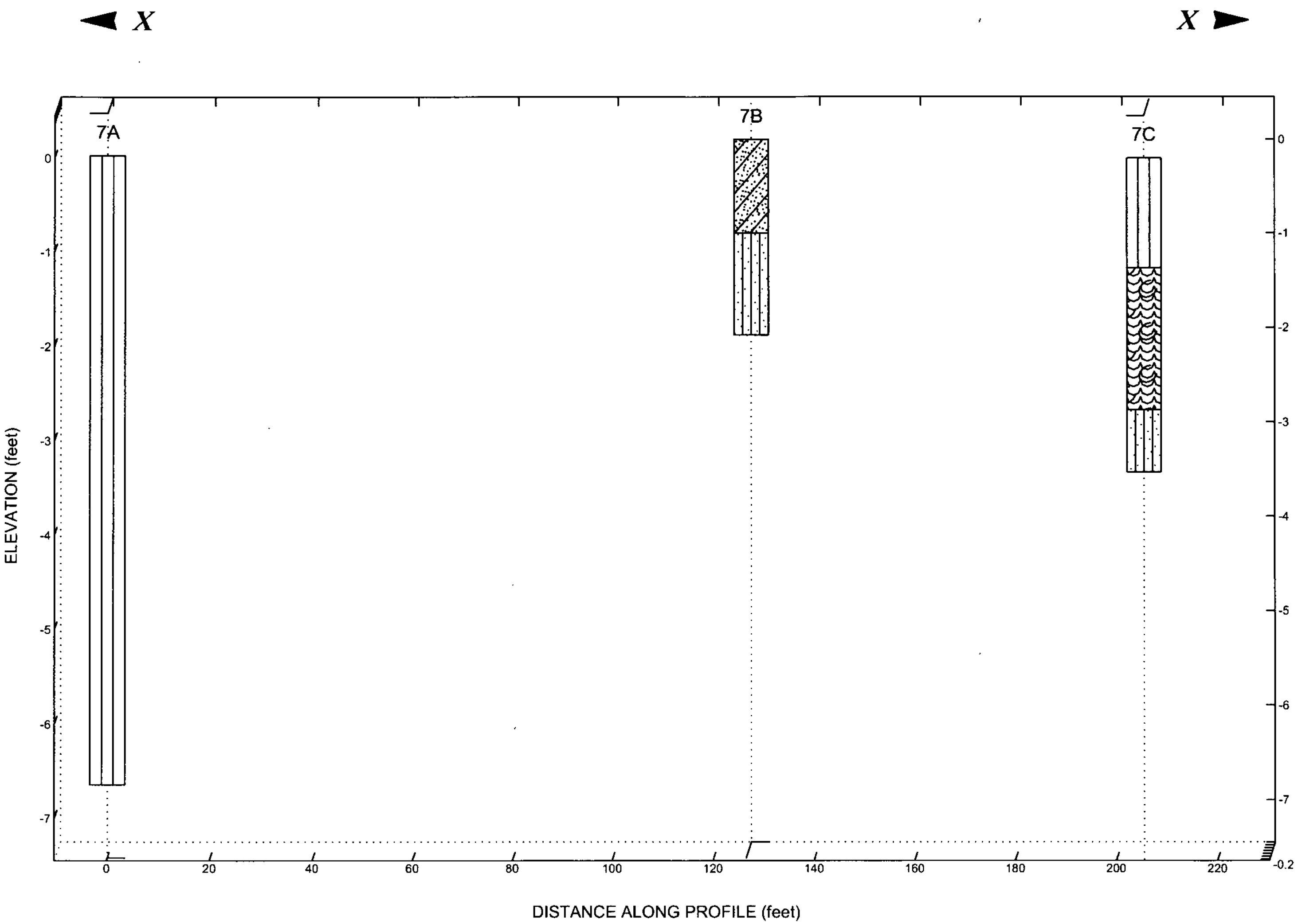
Malcolm Pirnie, Inc.

Location : Mile 6

MALCOLM PIRNIE

Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	6A - 6C



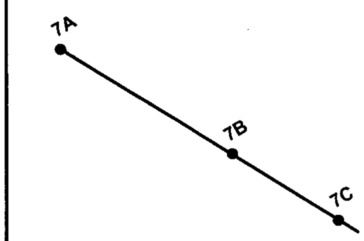
Lithology Graphics

Silt

Silty sand/Silt mix

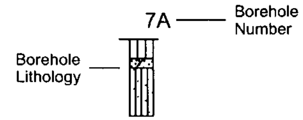
Silty Sand or Silt and Sand

Organic silt or clay with shells



Site Map Scale 1 inch equals 120 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.

Horizontal Scale (feet)

Vertical Exaggeration: 19x

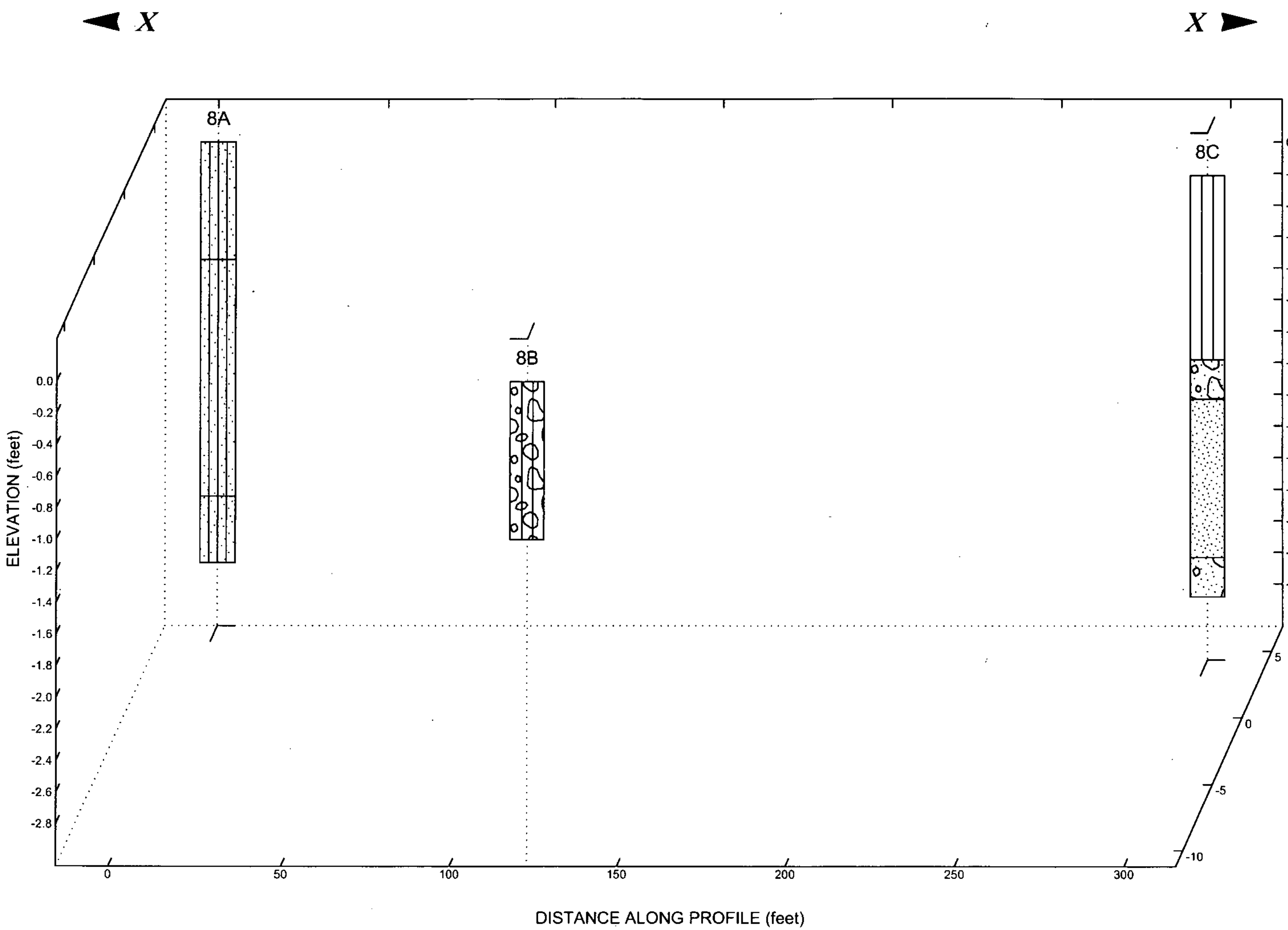
Malcolm Pirnie, Inc.

Location : Mile 7

MALCOLM PIRNIE

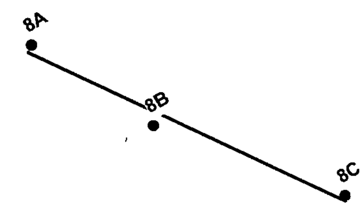
Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	7A - 7C



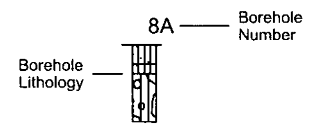
Lithology Graphics

- Silty Sand or Silt and Sand
- Sandy Silt
- Silty Gravel
- Silt
- Gravelly Sand
- Fine Sand
- Sandy Gravel



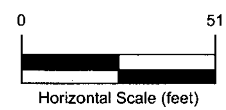
Site Map Scale 1 inch equals 165 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.



Vertical Exaggeration: 47x

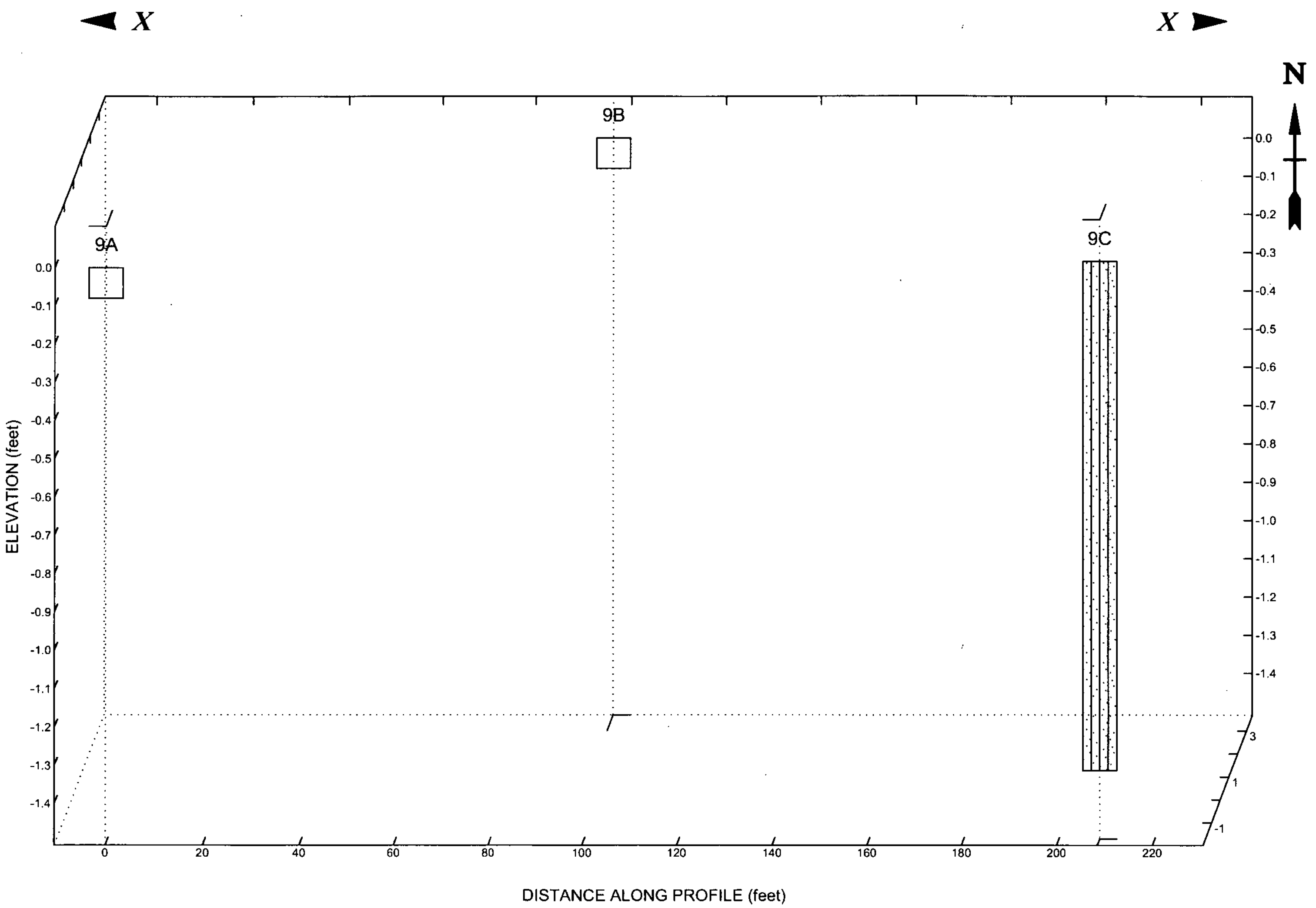
Malcolm Pirnie, Inc.

Location : Mile 8

MALCOLM PIRNIE

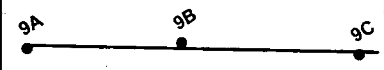
Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	8A - 8C



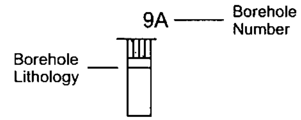
Lithology Graphics


Silty Sand or Silt and Sand



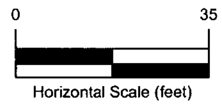
Site Map Scale 1 inch equals 120 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.



Vertical Exaggeration: 81.5x

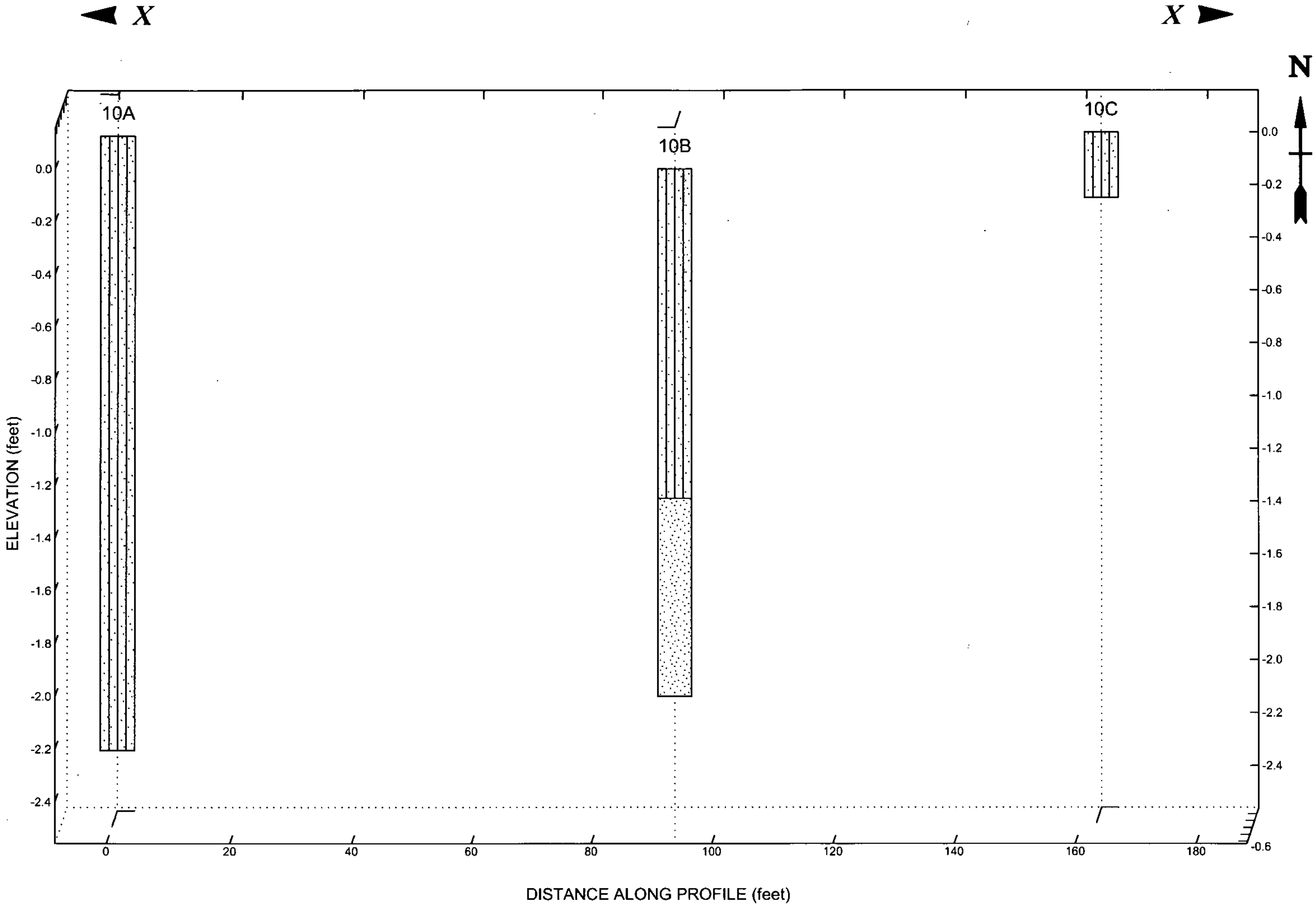
Malcolm Pirnie, Inc.

Location : Mile 9

MALCOLM PIRNIE

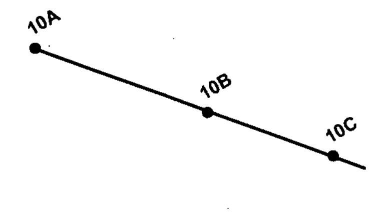
Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	9A - 9C



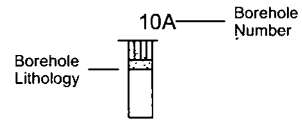
Lithology Graphics

Silty Sand or Silt and Sand
Fine Sand



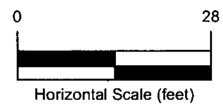
Site Map Scale 1 inch equals 100 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.



Vertical Exaggeration: 44x

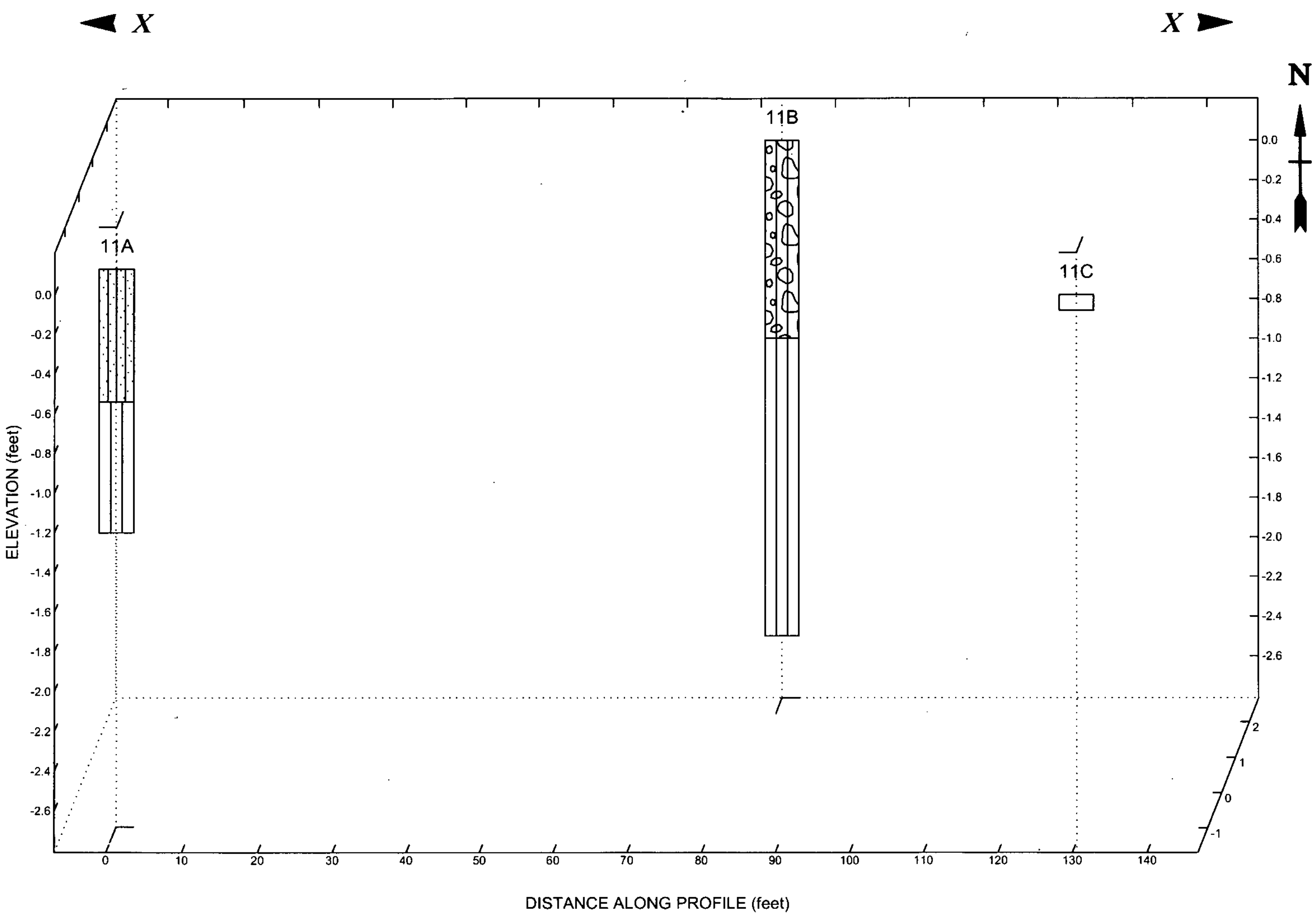
Malcolm Pirnie, Inc.

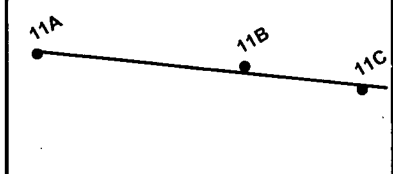
Location : Mile 10

MALCOLM PIRNIE

Lower Passaic River
New Jersey

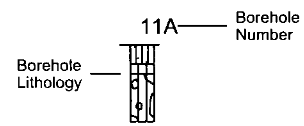
JOB NUMBER	TRANSECT NUMBER
3473007	10A - 10C





Site Map Scale 1 inch equals 75 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 23

Horizontal Scale (feet)

Vertical Exaggeration: 27x

Lithology Graphics

Silty Sand or Silt and Sand | Silt | Silty Gravel

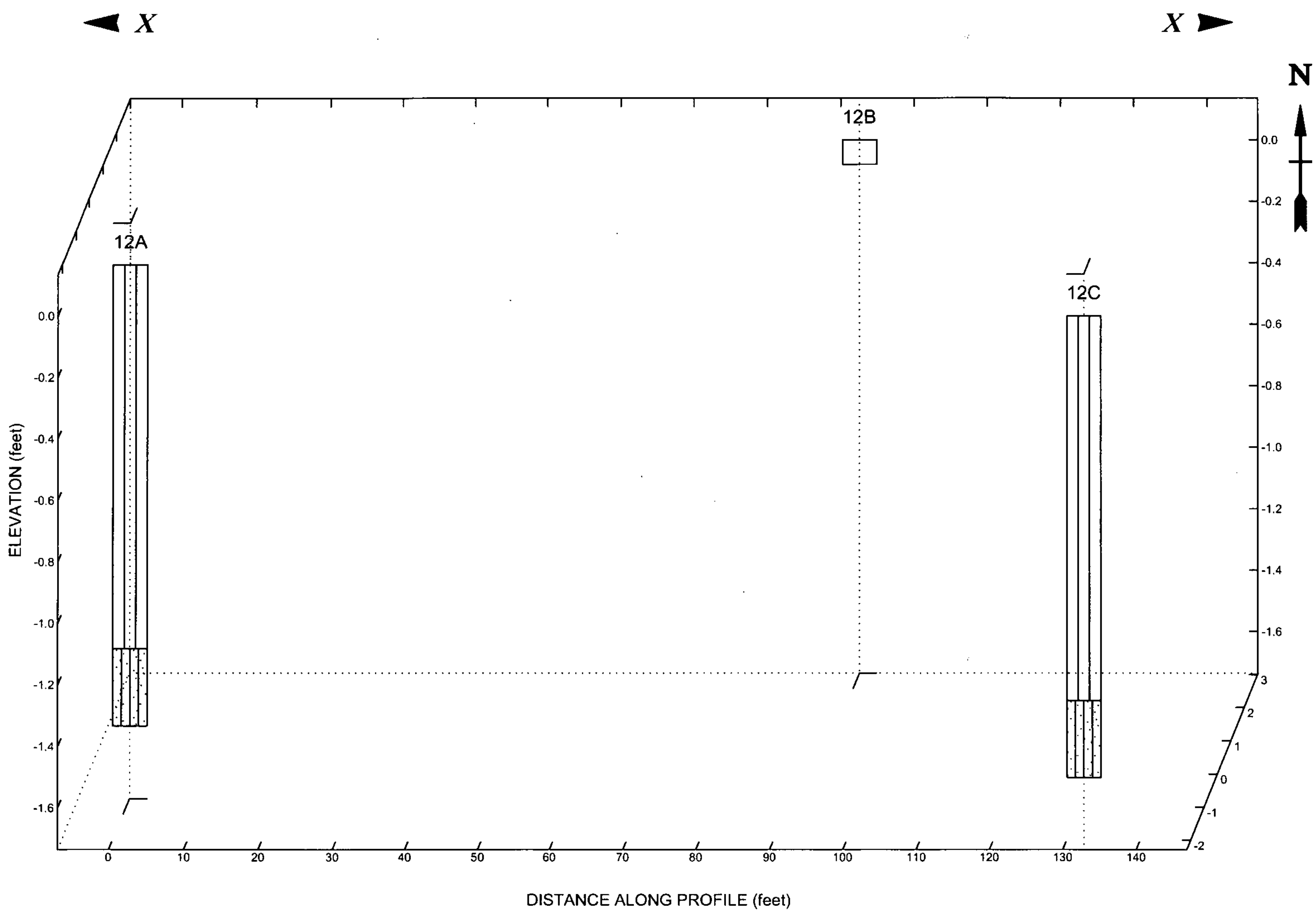
Malcolm Pirnie, Inc.

Location : Mile 11

MALCOLM PIRNIE

Lower Passaic River
New Jersey

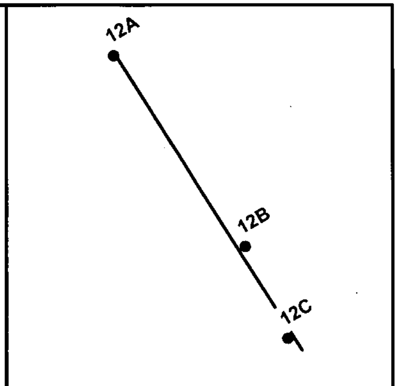
JOB NUMBER	TRANSECT NUMBER
3473007	11A - 11C



Lithology Graphics

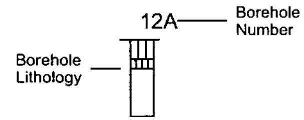
Silt

Silty Sand or Silt and Sand



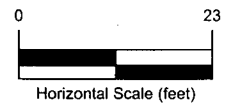
Site Map Scale 1 inch equals 75 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.



Vertical Exaggeration: 42.5x

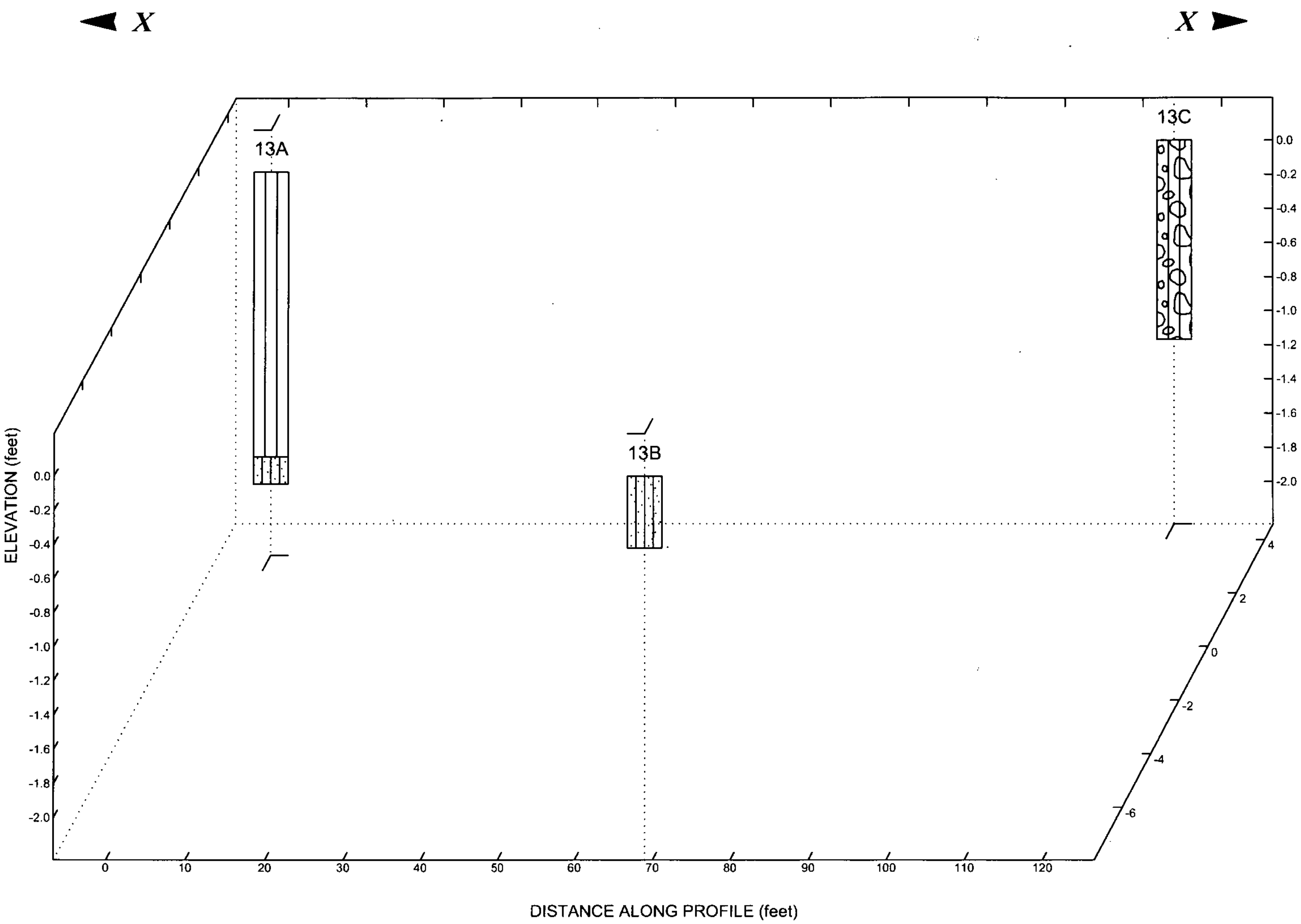
Malcolm Pirnie, Inc.

Location : Mile 12

MALCOLM PIRNIE

Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	12A - 12C

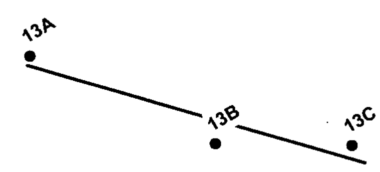


Lithology Graphics

Silt

Silty Sand or Silt and Sand

Silty Gravel



Site Map Scale 1 inch equals 65 feet

Explanation

13A — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 22

Horizontal Scale (feet)

Vertical Exaggeration: 22x

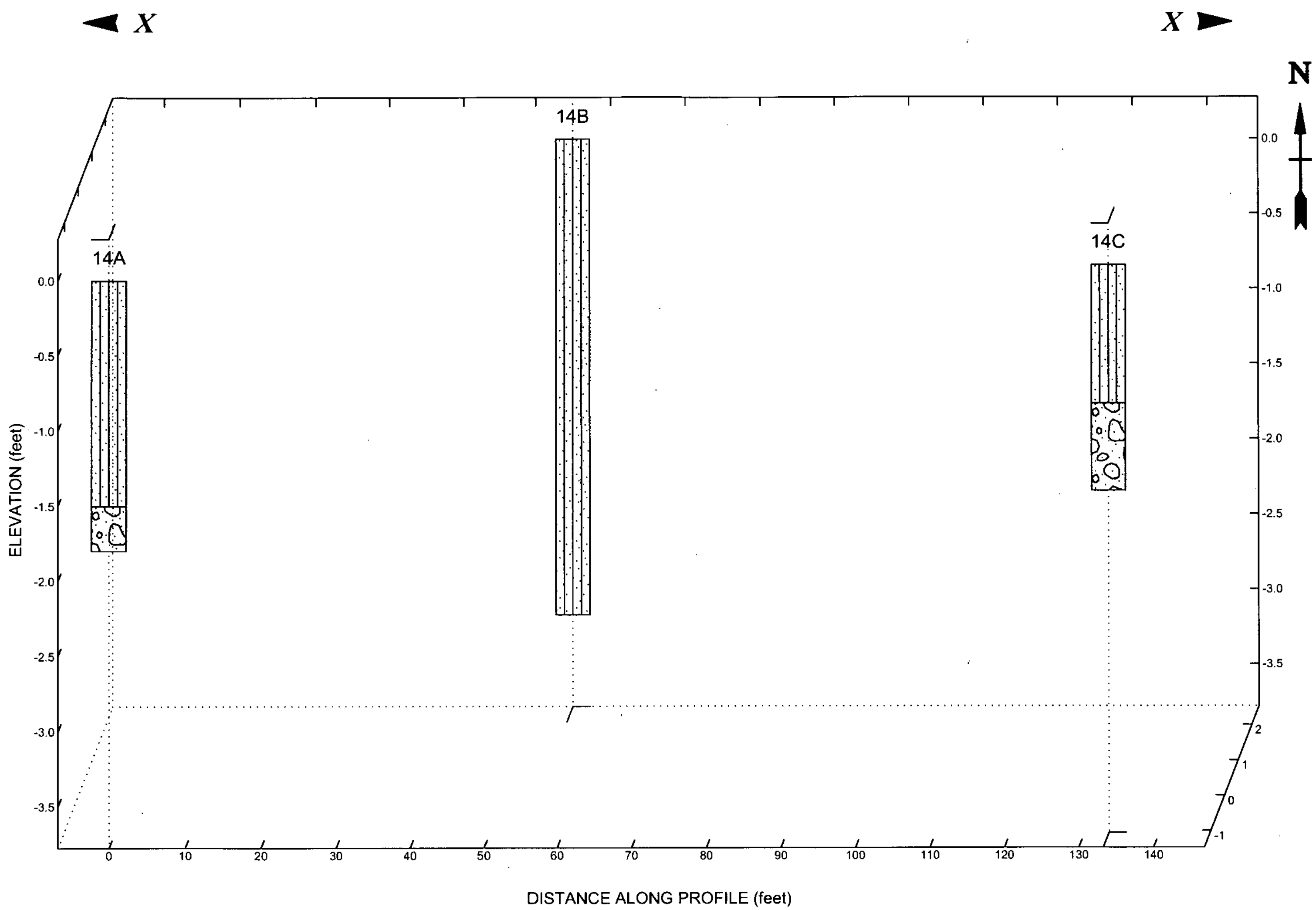
Malcolm Pirnie, Inc.

Location : Mile 13

MALCOLM PIRNIE

Lower Passaic River
New Jersey

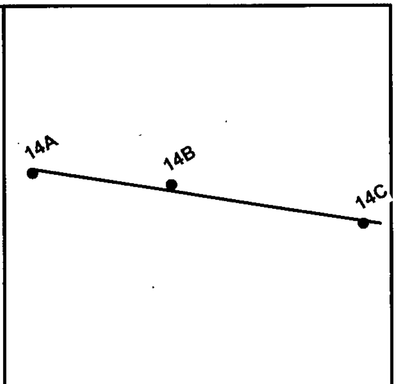
JOB NUMBER	TRANSECT NUMBER
3473007	13A - 13C



Lithology Graphics

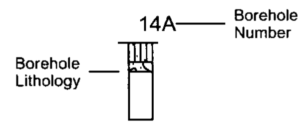
Silty Sand or Silt and Sand

Gravelly Sand



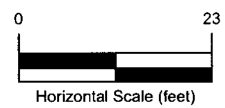
Site Map Scale 1 inch equals 75 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.



Vertical Exaggeration: 20.5x

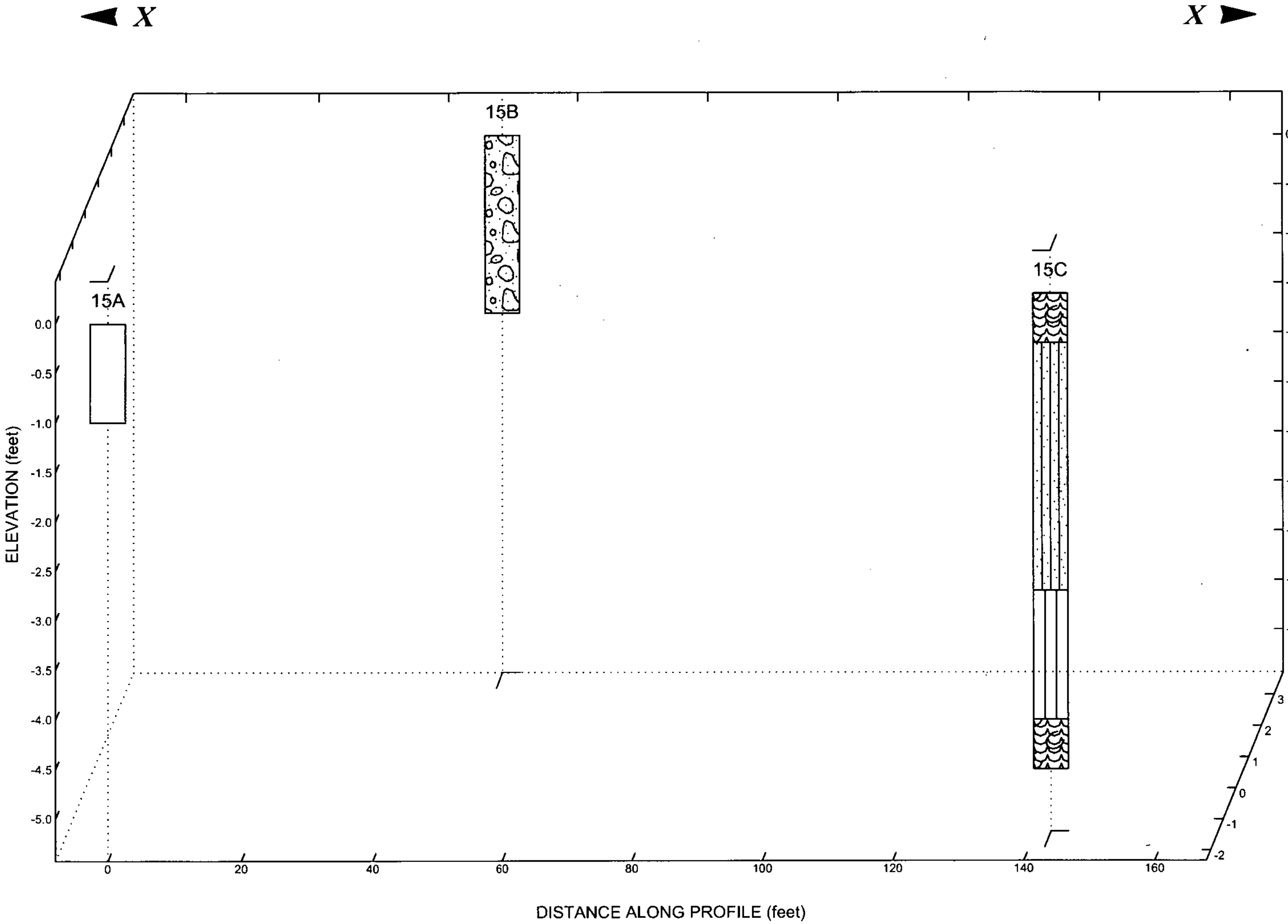
Malcolm Pirnie, Inc.

Location : Mile 14

MALCOLM PIRNIE

Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	14A - 14C



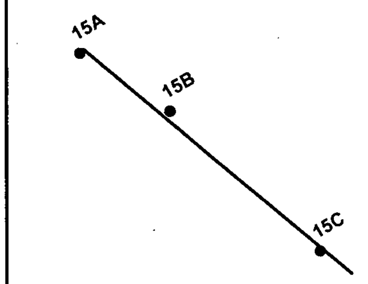
Lithology Graphics

Gravelly Sand

Organic silt or clay with shells

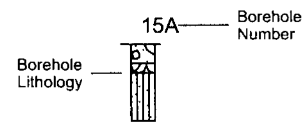
Silty Sand or Silt and Sand

Silt



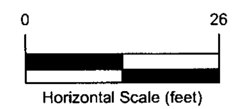
Site Map Scale 1 inch equals 90 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.



Vertical Exaggeration: 15.5x

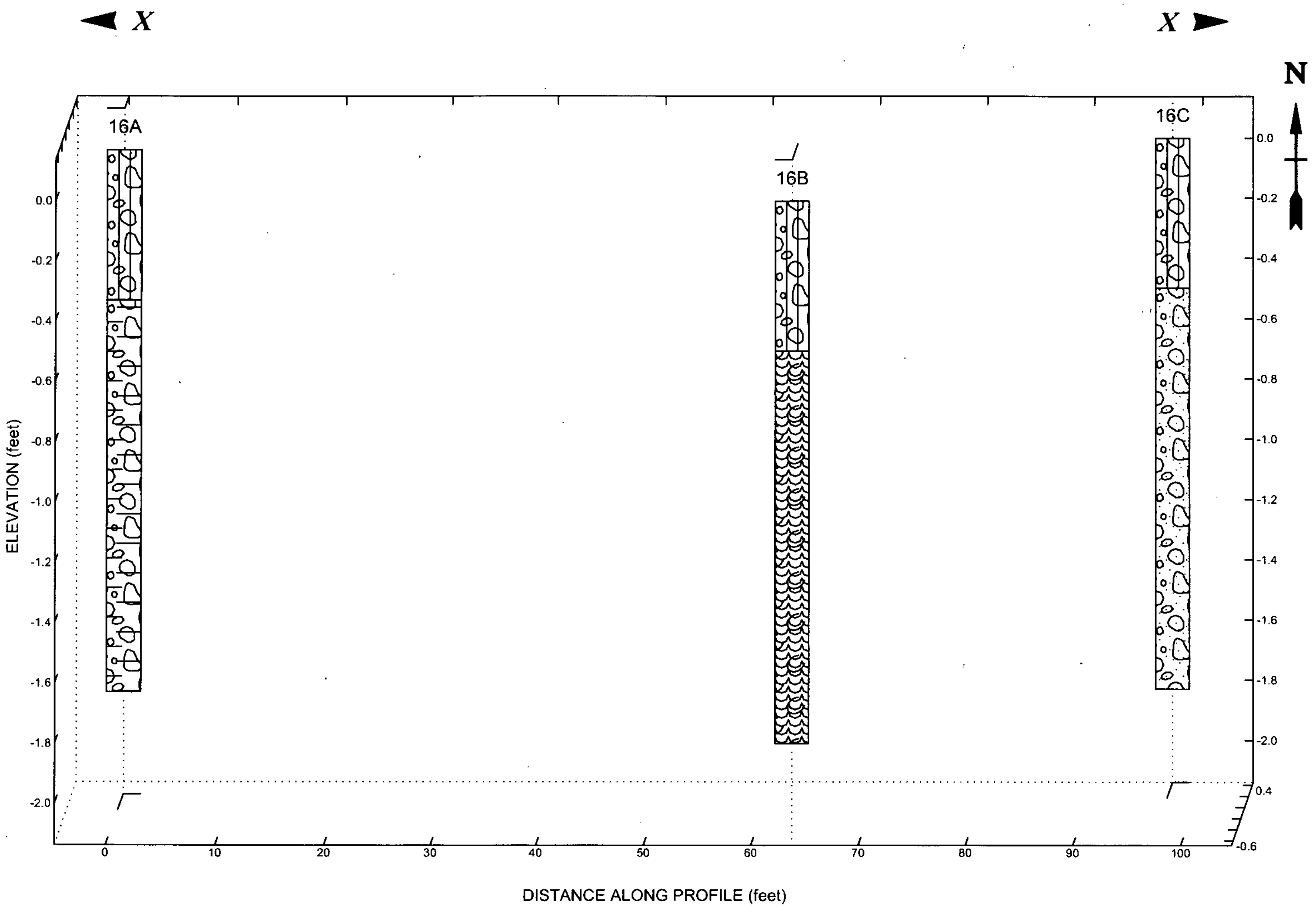
Malcolm Pirnie, Inc.

Location : Mile 15

MALCOLM PIRNIE

Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	15A - 15C



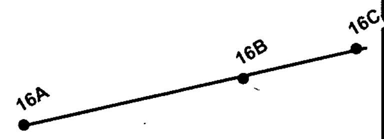
Lithology Graphics

Silty Gravel

Clayey Gravel

Organic silt or clay with shells

Gravelly Sand



Site Map Scale 1 inch equals 55 feet

Explanation

16A — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 16

Horizontal Scale (feet)

Vertical Exaggeration: 28.5x

Malcolm Pirnie, Inc.

Location : Mile 16

MALCOLM PIRNIE

Lower Passaic River
New Jersey

JOB NUMBER	TRANSECT NUMBER
3473007	16A - 16C

2005 Sediment Sampling and Radiological Results

Malcolm Pirnie, Inc. report summarizing sediment samples collected in August and September 2005 from the Lower Passaic River and analyzed for radiological data, including beryllium-7 and cesium-137. This attachment includes tables and a one-mile-per-plate map book. Note that the map book only includes select river miles where samples were collected: RM 0-1, RM 1-2, RM 2-3, RM 3-4, RM 4-5, RM 6-7, RM 7-8, RM 9-10, RM 10-11, RM 12-13, RM 13-14, and RM 17-18.

1.0 INTRODUCTION

Surface sediment samples from the Lower Passaic River and Dundee Lake were collected and analyzed for Beryllium-7 (Be^7) to aid in selecting high resolution coring locations. This report describes the Be^7 sampling methodology, the results of the sediment analysis, and the subsequent high resolution coring location selection based on the Be^7 data, as well as other information.

Be^7 analysis is a common tool used to indicate recent sediment deposition since this radionuclide has a 54-day half-life. If Be^7 is detected in surface sediments, then it is likely that those sediments were deposited within the last 6 months, indicating that the site is depositional at the time of sample collection. Recent deposition was considered along with indicators of historic deposition in the selection of high resolution coring locations. As part of the Be^7 sampling effort, samples were also analyzed for Cesium-137 (Cs^{137}), whose concentration is an important component of the high resolution core dating process. Sites for Be^7 sample collection were identified from historical sediment core data, bathymetric surveys, the side scan sonar survey, and field observations.

2.0 METHODOLOGY

Surface sediment samples were collected from a depth of approximately 0-1 cm with an Eckman dredge that was equipped with a custom built Plexiglas liner, designed to prevent "slump" in the collected sediment sample. Sampling sites were located in 12 different target areas (TA) located between river mile (RM) 0 and RM 16 and from above Dundee Dam. [These target areas were previously identified in Figure 4-2 of the Field Sampling Plan Volume 1 (Malcolm Pirnie, Inc., 2005). Note that while 13 areas are presented in this figure, no surface sediment samples were collected from TA 12 due to coarse or rocky bottom.] Approximately three samples were collected from each target area (one sample from each of three sites per target area). Additional samples were obtained from other locations outside target areas where field conditions or existing data suggested a good high resolution coring location. The data sets used in identifying target areas and individual sampling sites included:

- Sediment texture information based on the side scan sonar survey.
- Sedimentation rates calculated using historical bathymetric data.
- Location of previously collected core samples with an interpretable Cs^{137} profile (e.g., Tierra Solution, Inc. 1995 historic dated cores).

Table 1 lists the surface sediment samples collected for analysis. These samples were analyzed for Be^7, Cs^{137}, and percent moisture. If during sampling, the site conditions were not found to be suitable for future core collection, sediment samples were not collected or retained for analysis. The most common reasons to abandon a site were:

- Coarse-grained sediment unlikely to be depositional.
- Sediment layer too thin to yield a good core.

- Leafy or other debris present at the sediment surface.

Table 2 is a listing of the locations that were occupied and subsequently abandoned during surface sediment sampling and the rationale behind abandonment.

3.0 DISCUSSION OF RESULTS

Be^7 concentrations from the surface samples ranged from non-detect to 9.71 picocuries per gram (pCi/g). The maximum concentration was obtained from Sample ID 001, near RM 12.3. Relatively high Be^7 concentrations were typically located north of RM 8 while relatively lower concentrations were typically located south of RM 8.

Cs^{137} concentrations from the surface samples ranged from non-detect to 0.714 pCi/g. The maximum concentration was obtained from Sample ID 031, located above Dundee Dam. Cs^{137} concentrations from samples collected above RM 15 tended to be lower than those samples collected below RM 15.

Percent moisture in the samples ranged from 42% in the sample collected from Sample ID 008 (located at RM 2) to 81% in the sample collected from Sample ID 029 (located at RM 9).

Analytical results are presented in Table 1. These results were evaluated in conjunction with sediment texture and calculated sedimentation rates. High resolution coring locations were then selected based on the most favorable combination of sediment texture, depositional rate, and recent radiological results. The desired attributes for each criterion included:

- Positive Be^7 detection and local concentration maxima.
- Cs^{137} concentration consistent with recent deposition (approximately 0.4 pCi/g or less).
- Classification as a fine sediment texture, preferably silt.
- Sediment deposition rate greater than 0 inches per year, but less than 5 inches per year because areas with a relatively high deposition rate were more likely to have been recently dredged.

Of these criteria, a high Be^7 concentration and the appropriate sediment type were the most important, followed by the desired calculated deposition rate, and an appropriate Cs^{137} concentration. Table 3 lists the surface sediment sample locations selected as final high resolution coring locations. Sampling locations are plotted on the attached sedimentation-rate maps. Note that each map sheet represents one river mile; sections of the river that do not contain a sampling location are not provided.

4.0 LOCATION CLASSIFICATION

Sediment sampling sites were classified into four categories, which are discussed below:

- High Resolution Coring Locations.
- Potential High Resolution Coring Locations.
- Additional Core Top Sampling Locations.
- No additional sample collection.

The rationale behind the selection of each location is described in the below sections.

4.1 High Resolution Coring Locations

4.1.1 Sample ID 005 at RM 1.05

Sample ID 005 is located in the northeastern section of TA 1 and in sediment classified as silt. Of the three samples collected in TA 1, Sample ID 005 had the highest Be^7 concentration (0.74 pCi/g) and was located in an area with a deposition rate of 2-3 inches per year. The detected Cs^{137} concentration in this sample (0.1 pCi/g) was also indicative of recently deposited sediments.

4.1.2 Sample ID 007 at RM 1.4

Sample ID 007 (associated with Tierra Solutions, Inc. location number BBL 209) is located towards the eastern river bank between TA 1 and TA 2 and sediment classified as silt with a deposition rate of 2-3 inches per year. Be^7 results for the sample (1.04 pCi/g) suggest recent deposition, and the detected Cs^{137} concentration (0.17 pCi/g) is also indicative of recently deposited sediments.

4.1.3 Sample ID 009 at RM 2.2

Sample ID 009 is located in the northwestern part of TA 2 in sediment that is classified as silt. This site is located on the border of two depositional areas with the average rate of 3 inches per year. Of the two samples collected in TA 2, Sample ID 009 had the highest Be^7 concentration (1.39 pCi/g), and the detected Cs^{137} concentration (0.12 pCi/g) is also indicative of recently deposited sediments.

4.1.4 Sample ID 010 at RM 2.6

Sample ID 010 (associated with Tierra Solutions, Inc. location number BBL 222) is located in the southern part of the navigation channel between TA 2 and TA 3 in sediment classified as silt with a deposition rate of 1-2 inches per year. Be^7 results for the sample (0.85 pCi/g) and the detected Cs^{137} concentration (0.12 pCi/g) indicate that sediments were recently deposited.

4.1.5 Sample ID 017 at RM 3.5

Sample ID 017 (associated with Tierra Solutions, Inc. location number BBL 235) is located in the northern part of the navigation channel between TA 3 and TA 4 in sediment classified as silt and at the edge of an area with a deposition rate of 0-1 inches per year. The detected Be^7 concentration (0.64 pCi/g) in Sample ID 017 was the highest of the three samples collected in TA 3, and the Cs^{137} concentration (0.19 pCi/g), is indicative of recently deposited sediments.

4.1.6 Sample ID 018 at RM 4.1

Sample ID 018 is located in the northwestern part of TA 4 in sediment classified as silt. A deposition rate could not be calculated from the historical data for this specific location, but the sampling point is at the edge of an area with a deposition rate of 0-1 inches per year. The detected Be^7 concentration (1.34 pCi/g) in Sample ID 018 was the highest of the three samples collected in TA 4, and the Cs^{137} concentration (0.19 pCi/g) is indicative of recent deposition.

4.1.7 Sample ID 024 at RM 6.4

Sample ID 024 is located in the southwestern part of TA 6 in sediment classified as silt with a deposition rate of 1-2 inches per year. The detected Be^7 (0.818 pCi/g) and the Cs^{137} (0.13 pCi/g) concentrations are indicative of recent deposition.

4.1.8 Sample ID 026 at RM 7.8

Sample ID 026 is located in the middle of TA 7 in sediment classified as silt. A deposition rate could not be calculated from the historical data for that specific location, but the sampling point is at the edge of an area with a deposition rate of 0-1 inches per year. The detected Be^7 (2.47 pCi/g) and Cs^{137} (0.2 pCi/g) concentrations are indicative of recent deposition.

4.1.9 Sample ID 013 at RM 10.0

Sample ID 013 is located in the northern part of TA 8 in an area classified as silt with a deposition rate of 2-3 inches per year. The detected Be^7 concentration (5.85 pCi/g) was the highest of the three samples collected in TA 8, and the detected Cs^{137} concentration (0.22) is also indicative of recent deposition.

4.1.10 Sample ID 028 at RM10.8

Sample ID 028 is located just outside of the TA 9 border to the south, between TA 8 and TA 9, in an area classified as silt with a deposition rate of 0-1 inches per year. The detected Be^7 (4.82 pCi/g) and Cs^{137} (0.241 pCi/g) concentrations are indicative of recent deposition.

4.1.11 Sample ID 029 at RM 11.0

Sample ID 029 is located in the southwestern part of TA 9 in an area classified as silt. While the historical deposition rate calculated for this area is -1 to 0 inches per year, the detected Be^7 (5.88 pCi/g) and Cs^{137} (0.306 pCi/g) concentrations are indicative of recent deposition. Note that the site is also located on the edge of an area with a deposition rate of 0-1 inches per year.

4.1.12 Sample ID 001 at RM 12.3

Sample ID 001 is located on the southern border of TA 10 in sediment classified as silt with a deposition rate of 2-3 inches per year. The detected Be^7 concentration (9.71 pCi/g) was the highest of the three samples collected in the TA 10 area, and the detected Cs^{137} (0.29 pCi/g) concentration is also indicative of recent deposition.

4.1.13 Sample ID 032 at RM 12.6

Sample ID 032 is located in the middle of TA 10 in sediment with a deposition rate of 0-1 inches per year. Historical classification suggests that the area is composed of rock and coarse gravel, but field observation of the sample collected indicated that the material consisted of sandy silt with approximately 20% sand. The detected Be^7 concentration (3.01 pCi/g) was the second highest of the three samples collected in the TA 10 area, and the detected Cs^{137} concentration (0.132 pCi/g) is consistent with recent deposition.

4.1.14 Sample ID 037 at RM 18.0

Sample ID 037 is located above the Dundee Dam near approximately RM 18. No historical information is available for this site, but field observation of the collected material indicated that the sediment consisted of silt with 15-20% fine sand. The detected Be^7 concentration (1.6 pCi.g) was the highest of the five samples collected above Dundee Dam. The detected Cs^{137} concentration (0.089 pCi/g) is consistent with recent deposition.

4.1.15 Sample ID 035 at RM 17.0

Sample ID 035 is also located above the Dundee Dam, southwest of Sample ID 037. No historical information is available for this site, but field observations of the collected material indicated that the sediment consisted of sandy silt with approximately 10-15% fine sand and 10-15% organic debris. The detected Be^7 concentration (0.89 pCi/g) was the second highest of the five samples collected above Dundee Dam, and the detected Cs^{137} concentration (0.148 pCi/g) is consistent with recent deposition.

4.2 Potential High Resolution Coring Locations

The following four sampling sites were identified as potential high resolution coring locations. These potential locations were established to serve as "back-up locations" in the event that a high-resolution core was not successfully obtained from the 15 primary coring locations. Potential locations would only be used to replace a local coring site (*e.g.*, Sample ID 006 might replace Sample ID 005). Information pertaining to these sites is summarized in the table below.

Sample ID	River Mile	Target Area	Sedimentation Rate (in/year)	Be-7 (pCi/g)	Cs-137 (pCi/g)	Notes
006	1.2	1	Border of 4-5 and >5	0.73	0.10	Recent deposition
020	3.8	4	0-1	0.54	0.12	Recent deposition
012	9.9	8	2-3	4.39	0.19	Recent deposition
031	12.5	10	Border of (-1)-0 and 0-1	3.13	0.71	Not continuously depositional

While in the field, a center channel station was also defined in TA 1 as a potential sampling location in the event that a successful high resolution core could not be collected from Sample ID 005 or Sample ID 006. No surface sediment core was collected from this area during the Be^7 program. This site was selected base on field observations and deposition rate calculations.

4.3 Additional Core Top Sampling

4.3.1 Sample ID 002 at RM 14.0

Sample ID 002 is located in the eastern part of TA 11 in sediment classified as silt and sand with a deposition rate of 1-2 inches per year. While the detected Be^7 level (5.08 pCi/g) was relatively high, the Cs^{137} level (0.07 pCi/g) was considered too low to be indicative of a site with continuous deposition. Sample ID 002 was not identified as a potential high resolution coring location; however, this site was identified for future core top sampling. Core top samples (0-1 cm) will be analyzed for a suite of chemicals to determine the contamination concentration in recently deposited sediments.

4.4 Locations Not Selected for Additional Sampling

The following sample locations were not selected for additional sample collection:

- Sample ID 003
- Sample ID 004
- Sample ID 008
- Sample ID 011
- Sample ID 014
- Sample ID 015
- Sample ID 016
- Sample ID 019
- Sample ID 021
- Sample ID 022
- Sample ID 023
- Sample ID 034
- Sample ID 036
- Sample ID 036 dup
- Sample ID 038

Table 1

Be[7] Sampling Locations

Field Sample ID	PREmis Sample ID	Date Collected	Time Collected	Water Depth (ft)	Probe Depth (ft)	Northing	Easting	Be-7 (pCi/g)	Be-7 error (+/-) (pCi/g)	Cs-137 (pCi/g)	Cs-137 error (+/-) (pCi/g)	Percent Moisture (%)	River Mile	Target Area	Associated BBL location	Description and Comments
001	LPRP-SCSS-PSR-000020	08/29/2005	03:15:00PM	8	4.5	728363.9	596911.9	9.71	2.75	0.29	0.038	62.80	12.3	10		Gray silt with trace fine sand
002	LPRP-SCSS-PSR-000021	08/29/2005	04:30:00PM	11.5	6	737051.2	597369.9	5.08	1.43	0.07	0.026	64.20	14.0	11		Dark brown, low plasticity silt with approx. 30% fine sand
003	LPRP-SCSS-PSR-000022	08/30/2005	10:05:00AM	9.5		688848.4	597504.8	0.531	0.240	0.133	0.018	48.10	1.00	1		Brownish gray low plasticity silt with trace fine sand
004	LPRP-SCSS-PSR-000023	08/30/2005	10:15:00AM	9		689076.8	597585.6	0.409	0.123	0.097	0.016	61.20	1.03	1		Brownish gray low plasticity silt with trace fine sand
005	LPRP-SCSS-PSR-000024	08/30/2005	10:50:00AM	8		689423.9	597694.4	0.738	0.244	0.148	0.017	64.60	1.05	1		Brownish gray low plasticity silt with trace fine sand; organic material observed
006	LPRP-SCSS-PSR-000025	08/30/2005	11:05:00AM	8	> 8	689974.3	597313.8	0.729	0.239	0.100	0.016	59.10	1.2	1		Brownish gray low plasticity silt with trace fine sand
007	LPRP-SCSS-PSR-000027	08/30/2005	11:30:00AM	9 to 10		691134.5	598082.7	1.04	0.325	0.169	0.069	64.20	1.4	bet 1, 2	209	Brown-gray silt with approx. 15% fine sand and trace organics; strong sewage odor
008	LPRP-SCSS-PSR-000028	08/30/2005	12:00:00PM	11	5	693995.4	598123.4	0.443	0.244	0.094	0.011	42.10	2.0			Brown-gray silt with approx. 15% fine sand and trace organics; strong sewage odor
009	LPRP-SCSS-PSR-000029	08/30/2005	12:20:00PM	4	> 7.5	694855.0	597581.8	1.39	0.401	0.124	0.029	76.20	2.2	2		Dark brown silt with approx. 15% fine sand and 10-20% organic debris
010	LPRP-SCSS-PSR-000030	08/30/2005	01:05:00PM	12	> 6	695468.4	595394.1	0.852	0.252	0.120	0.014	61.90	2.6	bet 2,4	222	Brownish gray silt with trace fine sand and approx 15% organic debris; hard crust felt during probing
011	LPRP-SCSS-PSR-000031	08/30/2005	03:55:00PM	7	> 6	717395.0	592093.0	1.020	0.293	0.106	0.010	50.30	9.8	8		Brownish gray silt with 30% fine sand
012	LPRP-SCSS-PSR-000032	08/30/2005	04:15:00PM	5		718091.0	591954.0	4.390	1.230	0.189	0.053	75.80	9.9	8		Brownish green low plasticity silt with trace fine sand; high water content
013	LPRP-SCSS-PSR-000033	08/30/2005	04:30:00PM	7	> 8	718844.0	592139.0	5.850	1.630	0.224	0.018	78.80	10.0	8		Brownish green low plasticity silt with trave fine sand; high water content; probe tight at bottom
014	LPRP-SCSS-PSR-000034	09/01/2005	11:00:00AM	19	> 4	695347.0	593116.0	0.276	0.077	0.203	0.020	67.40	3.1	3	230	Gray-black, low plasticity silt with trace clay; slight odor
015	LPRP-SCSS-PSR-000035	09/01/2005	11:40:00AM	12	> 6	695235.0	593232.0	0.210	0.095	0.135	0.013	55.20	3.1	3	228	Dark brown-black silt with trace clay; significant organic matter (leaves, twigs, roots) retrieved with samples
016	LPRP-SCSS-PSR-000036	09/01/2005	12:05:00PM	15	> 3 to 4	695521.0	393692.0	0.225	0.077	0.173	0.011	63.80	2.9	3		Brownish silt with trace clay and 10-20 % sand
017	LPRP-SCSS-PSR-000037	09/01/2005	01:00:00PM	15	> 4	694335.0	591088.0	0.637	0.193	0.350	0.033	63.80	3.5	bet 3,4	235	Grayish-black silt with little sand, trace clay, and trace organic debris
018	LPRP-SCSS-PSR-000038	09/01/2005	01:35:00PM	6	8	692630.0	589232.0	1.340	0.374	0.185	0.015	42.50	4.1	4	241 (ballpark)	Brownish black silt with trace clay and trace to little leaf litter
019	LPRP-SCSS-PSR-000039	09/01/2005	02:10:00PM	18	soft	692312.0	589331.0	0.139	0.039	0.104	0.018	46.30	4.1	4		Brownish black silt with trace clay, little fine sand, and little coarse sand
020	LPRP-SCSS-PSR-000040	09/01/2005	02:35:00PM	17	soft	692949.0	590463.0	0.541	0.169	0.124	0.014	49.10	3.8	4		Grayish brown silt
021	LPRP-SCSS-PSR-000041	09/01/2005	03:15:00PM	8	soft	692971.0	586227.0	0.011	0.008	0.142	0.026	60.20	4.7	5	251	Dark brownish black silt with trace clay and little to trace sand
022	LPRP-SCSS-PSR-000042	09/06/2005	09:40:00AM	16	> 4	694051.1	585621.2	0.217	0.095	0.134	0.020	55.00	4.9	5		Brown-gray silt with approx. 10% fine sand
023	LPRP-SCSS-PSR-000043	09/02/2005	10:10:00AM	17.5	> 3	694785.9	585416.3	0.376	0.140	0.123	0.013	51.10	5.1	5		Grayish-black silt with approx. 10% fine sand; sulfur (rotten eggs) odor
024	LPRP-SCSS-PSR-000044	09/02/2005	11:05:00AM	13	4	701755.2	585490.1	0.818	0.235	0.130	0.140	45.20	6.4	6		Silt with at least 30% sand
026*	LPRP-SCSS-PSR-000045	09/02/2005	12:35:00PM	12	3	708047.0	588852.0	2.470	0.698	0.200	0.020	66.20	7.8	7		Dartk brown silt with trace fine sand
028	LPRP-SCSS-PSR-000046	09/02/2005	01:55:00PM	5	> 4	722786.7	592666.5	4.820	1.340	0.241	0.024	75.80	10.8	9		Greenish brown low plasticity silt with trace fine sand
029	LPRP-SCSS-PSR-000047	09/02/2005	02:45:00PM	4.5	> 5	723366.3	593419.6	5.880	1.630	0.306	0.029	80.50	11.0	9		Greenish brown low plasticity silt with trace fine sand
031	LPRP-SCSS-PSR-000048	09/02/2005	03:20:00PM	8.5	4	729263.2	596532.5	3.130	0.883	0.714	0.050	70.00	12.5	10		Brownish green low plasticity silt with trace fine sand and trace clay
032	LPRP-SCSS-PSR-000049	09/02/2005	03:55:00PM	6	soft silt	729624.2	596399.6	3.010	0.842	0.132	0.011	61.80	12.6	10		Brownish sandy silt with 20% fine sand; sample collected in 3 feet of water
034	LPRP-SCSS-PSR-000050	09/06/2005	03:10:00PM	5	> 3	747318.0	594381.0	0.001	0.001	0.009	0.005	59.50	17.0	above DD		Dark brown sandy silt with approx. 30% fine sand and trace organic debris
035	LPRP-SCSS-PSR-000051	09/06/2005	03:40:00PM	4	> 5	747930.0	594041.0	0.890	0.257	0.148	0.012	61.60	17.0	above DD	01A	Dark brown sandy silt with approx. 10-15% fine sand and approx. 10-15% organic debris
036	LPRP-SCSS-PSR-000052	09/06/2005	04:40:00PM	1	3	747660.0	594325.0	0.169	0.094	0.122	0.021	45.10	17.0	above DD		Dark brown silt with approx. 30% fine sand
036 dup	LPRP-SCSS-PSR-000053	09/06/2005	04:45:00PM	1	3	747660.0	594325.0	0.348	0.107	0.084	0.015	42.60	17.0	above DD		Dark brown silt with approx. 30% fine sand
037	LPRP-SCSS-PSR-000055	09/08/2005	09:35:00AM	6	> 3 to 4	750527.0	594773.0	1.600	0.451	0.089	0.008	59.10	18.0	above DD		Brown silt with 15-20% fine sand; petroleum odor
038	LPRP-SCSS-PSR-000056	09/08/2005	09:55:00AM	5	4	750910.0	594653.0	0.464	0.161	0.043	0.007	46.00	18.0	above DD		Brown silt with 10-20% fine sand; petroleum odor (slightly stronger than that at 037)

Note:

* GPS not working, coordinates are approximate

Table 2
Abandoned Potential Be^7 Sampling Locations

Field ID	Date	Time	Water Depth (ft)	Probe Depth (ft)	Northing	Easting	Target Area	Sample/Probe	Reason for Abandonment
008	8/30/2005	11:45	5		698772.7	598104.9		sample	Too much organic material to collect a silt sample
018	9/1/2005	13:15	8	> 7	692573.0	589490.0	4	sample	Leaf litter obtained; silt could not be collected
019	9/1/2005	13:45	5	> 6	692695.0	589859.0	4	sample	Leaf litter obtained; silt could not be collected
021A	9/2/2005	10:00	16	> 4	694061.0	585634.9	5	probe	Silt over sandy bottom
024A	9/2/2005	10:30	10	4	701000	585250	6	sample	Was not able to retrieve sediment
024	9/2/2005	10:40	9	4	701255.84	585364.57	6	probe	< than three feet of mud
025	9/2/2005	11:20		< 3	703700	586511		probe	< than three feet of mud
025	9/2/2005		18		704028.56	586971.82		probe	18 ft of water and gravel
025	9/2/2005	11:35	10	4	704537.08	587224.4		probe	Boat drifted
025	9/2/2005	11:51	7	3	704712.65	587303.88		probe	Spotty mud
026	9/2/2005				708200	589000	7	probe	Sandy
027	9/2/2005	12:45	3.5	3.5	707460.56	588320.63		probe	Silt underlain by sand
027	9/2/2005				707416	588323		probe	Hard bottom
029	9/2/2005		4.5	5	723427.6	593351	8	probe	Sandy bottom
030	9/2/2005				723558.6	593861.73		probe	Sand
030	9/2/2005				723505.9	53382.75		probe	2.5 ft of mud
033	9/2/2005	16:20			737600	597392	11	probe	sand
033	9/2/2005		3.5	1	737817	597498	11	probe	only 1' silt
033	9/2/2005				738184	597689	11	probe	sand
033	9/2/2005				738268.58	597916.5	11	probe	sand
033	9/2/2005				738310	598793	11	probe	Sand
033	9/2/2005		approx 3		737353.27	599360.63	11	probe	Sand with a little bit of silt
036A	9/6/2005	16:00	2	> 4 silt	748178	594317	above DD	sample	Sandy material retrieved
036B	9/6/2005	16:10	1	> 2	747990	594345	above DD	sample	Sandy material retrieved
036C	9/6/2005	16:15		sand	749158	594500	above DD	probe	Sandy material retrieved
036D	9/6/2005	16:20	> 10	sand	749078	594773	above DD	probe	Sandy material retrieved
037A	9/7/2005	9:05	2	4 soft	749477	594432	above DD	sample	First drop didn't release properly; second yielded sand
037B	9/7/2005	9:10	> 2	sand	749454	594795	above DD	probe	Sand
037C	9/7/2005	9:15	deep	sand	749521	594857	above DD	probe	Sand
037D	9/7/2005	9:20	8	sand	749770	594720	above DD	probe	Sand
039	9/7/2005	10:00		cs	750940	594397	above DD	probe	Coarse sand
040A	9/7/2005	14:30	3.5	cs, gr, rock	742348	598920	12	probe	Coarse sand, gravel, and rock
040B	9/7/2005	14:35	3	rock, gr	742077	598817	12	probe	Rock and gravel
040C	9/7/2005	14:40	4	rock, gr	741987	598998	12	probe	Rock and gravel
040D	9/7/2005	14:43	4	rock	741803	599203	12	probe	Rock
040E	9/7/2005	14:44	5	rock	741726	399175	12	probe	Rock
040F	9/7/2005	14:46	9	rock, gr	741474	599440	12	probe	Rock and gravel
040G	9/7/2005	14:47	5	rock	741411	599358	12	probe	Rock
040H	9/7/2005	14:48	4.5	rock	741119	599422	12	probe	Rock
040I	9/7/2005	14:49	5.5	rock	741097	599551	12	probe	Rock
040J	9/7/2005	14:53	5.5	rock	740436	599623	12	probe	Rock
040K	9/7/2005	14:55	5.5	gr, rock	740259	599866	12	probe	Gravel and rock
040L	9/7/2005	14:56			740060	600114	12	probe	Too deep to probe
040M	9/7/2005	14:48	6.5	rock	740059	600263	12	probe	Rock
040N	9/7/2005	15:00	5	rock	739657	600538	12	probe	Rock
040O	9/7/2005	15:02	3.5	rock	739643	600699	12	probe	Rock

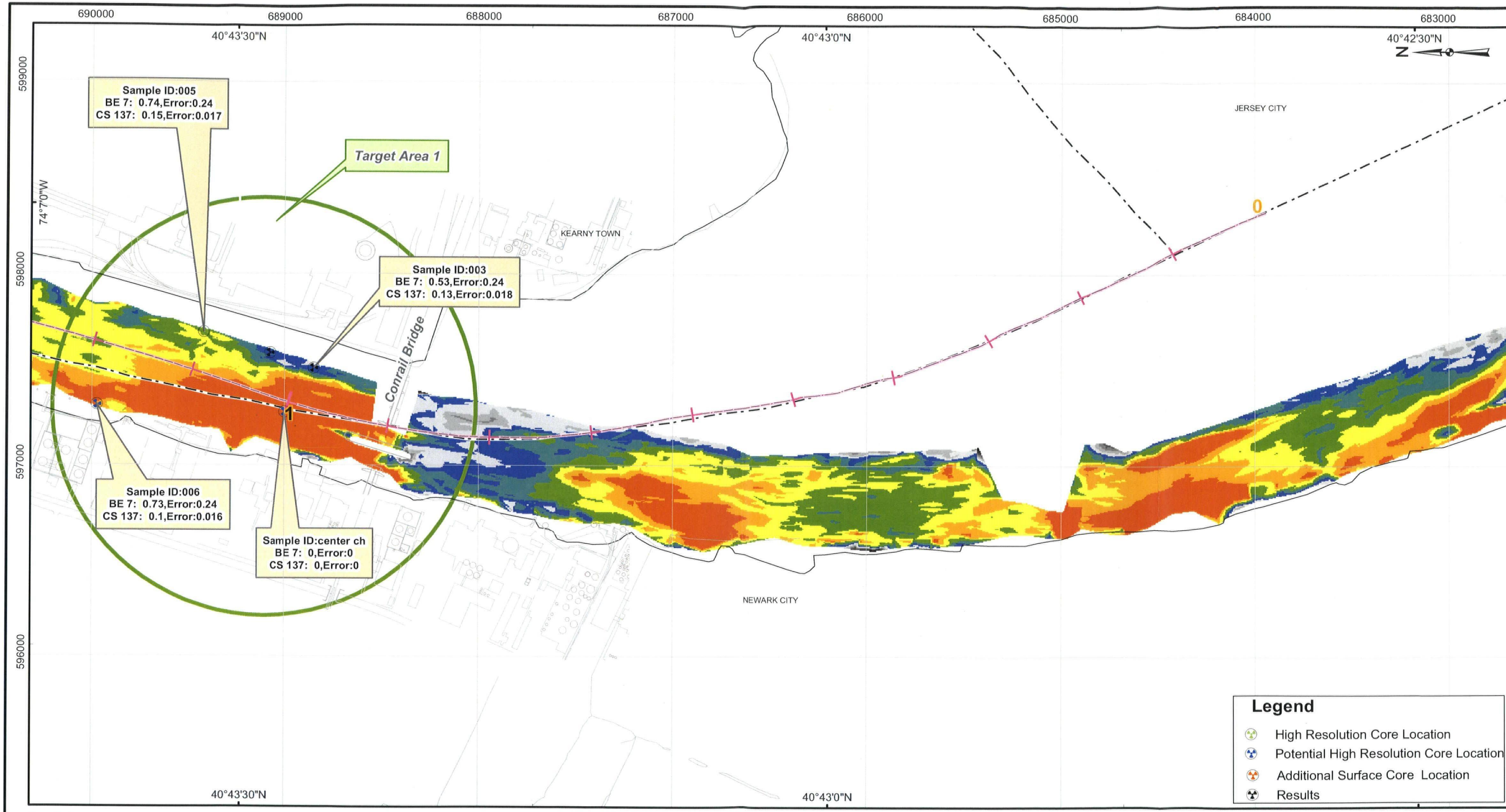
Total abandoned locations = 47

Table 3
High Resolution Core Sites

Sample Type	Field Sample ID	Water Depth (ft)	Probe Depth (ft)	Northing	Easting	Be-7 (pCi/g)	Be-7 error (+/-) (pCi/g)	Cs-137 (pCi/g)	Cs-137 error (+/-) (pCi/g)	Percent Moisture (%)	River Mile	Target Area	Associated BBL location	Description and Comments
core	005	8		689423.9	597694.4	0.738	0.244	0.148	0.017	64.60	1.05	1		Brownish gray low plasticity silt with trace fine sand; organic material observed
potential location	006	8	> 8	689974.3	597313.8	0.729	0.239	0.100	0.016	59.10	1.2	1		Brownish gray low plasticity silt with trace fine sand
potential location	center channel			689000.0	597275.0							1		Center channed station not sampled during the Be-7 program.
core	007*	9 to 10		691134.5	598082.7	1.04	0.325	0.169	0.069	64.20	1.4	bet 1, 2	209	Brown-gray silt with approx. 15% fine sand and trace organics; strong sewage odor
core	009	4	> 7.5	694855.0	597581.8	1.39	0.401	0.124	0.029	76.20	2.2	2		Dark brown silt with approx. 15% fine sand and 10-20% organic debris
core	010*	12	> 6	695468.4	595394.1	0.852	0.252	0.120	0.014	61.90	2.6	bet 2,3	222	Brownish gray silt with trace fine sand and approx 15% organic debris; hard crust felt during probing
core	017*	15	> 4	694335.0	591088.0	0.637	0.193	0.350	0.033	63.80	3.5	bet 3,4	235	Grayish-black silt with little sand, trace clay, and trace organic debris
core	018*	6	8	692630.0	589232.0	1.340	0.374	0.185	0.015	42.50	4.1	4	241	Brownish black silt with trace clay and trace to little leaf litter
potential location	020	17	soft	692949.0	590463.0	0.541	0.169	0.124	0.014	49.10	3.8	4		Grayish brown silt
core	024	13	4	701755.2	585490.1	0.818	0.235	0.130	0.140	45.20	6.4	6		Silt with at least 30% sand
core	026*	12	3	708047.0	588852.0	2.470	0.698	0.200	0.020	66.20	7.8	7		Dartk brown silt with trace fine sand
core	013	7	> 8	718844.0	592139.0	5.850	1.630	0.224	0.018	78.80	10.0	8		Brownish green low plasticity silt with trave fine sand; high water content; probe tight at bottom
potential location	012	5		718091.0	591954.0	4.390	1.230	0.189	0.053	75.80	9.9	8		Brownish green low plasticity silt with trace fine sand; high water content
core	028	5	> 4	722786.7	592666.5	4.820	1.340	0.241	0.024	75.80	10.8	9		Greenish brown low plasticity silt with trace fine sand
core	029	4.5	> 5	723366.3	593419.6	5.880	1.630	0.306	0.029	80.50	11.0	9		Greenish brown low plasticity silt with trace fine sand
core	001	8	4.5	728363.9	596911.9	9.71	2.75	0.29	0.038	62.80	12.3	10		Gray silt with trace fine sand
core	032	6	soft silt	729624.2	596399.6	3.010	0.842	0.132	0.011	61.80	12.6	10		Brownish sandy silt with 20% fine sand; sample collected in 3 feet of water
potential location	031	8.5	4	729263.2	596532.5	3.130	0.883	0.714	0.050	70.00	12.5	10		Brownish green low plasticity silt with trace fine sand and trace clay
core top	002	11.5	6	737051.2	597369.9	5.08	1.43	0.07	0.026	64.20	14.0	11		Dark brown, low plasticity silt with approx. 30% fine sand
core	035	4	> 5	747930.0	594041.0	0.890	0.257	0.148	0.012	61.60	17.0	above DD	01A	Dark brown sandy silt with approx. 10-15% fine sand and approx. 10-15% organic debris
core	037	6	> 3 to 4	750527.0	594773.0	1.600	0.451	0.089	0.008	59.10	18.0	above DD		Brown silt with 15-20% fine sand; petroleum odor

NOTES:
Potential locations are alternate spots to collect a sample if the defined core location cannot be successfully sampled.
DoC = depth of contamination

Field Sample ID	Note
007	Near BBL ID 209. Cs-137 extends to 5 ft. Anticipated DoC of 10 ft.
010	Near BBL ID 222. Cs-137 extends to 11.5 ft. Anticipated DoC of 23 ft.
017	Near BBL ID 235. Cs-137 extends to 6.5 ft. Anticipated DoC of 13 ft.
018	Near BBL ID 241. Cs-137 extends to 8.5 ft. Anticipated DoC of 16 ft.
01A	



Lower Passaic River
Restoration Project
New Jersey

Sediment Samples and Radiological Results

US Army Corps of Engineers

MALCOLM PIRNIE

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data
River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet Radiological results in pCi/gt

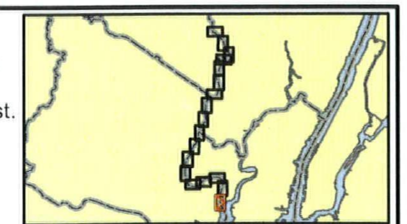
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

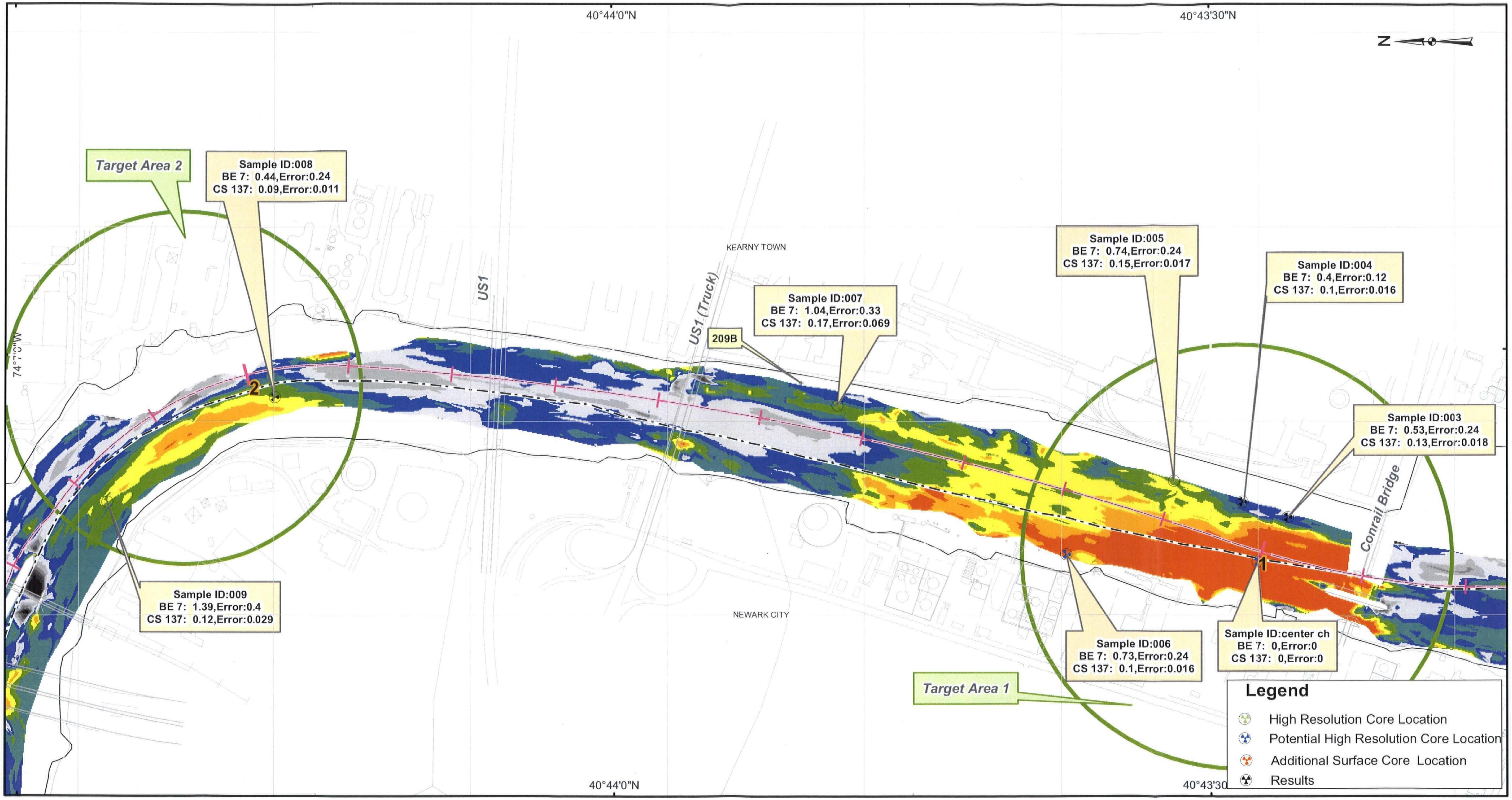
Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 0 to 1

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\Mile_0_1_Portrait.mxd)
11/30/2005 -- 8:33:15 AM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

- < -5
- -5 to -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- > 5

+ BBL Data

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet   Radiological results in pCi/gt

0 250 500 1,000

1 " equals 500 '

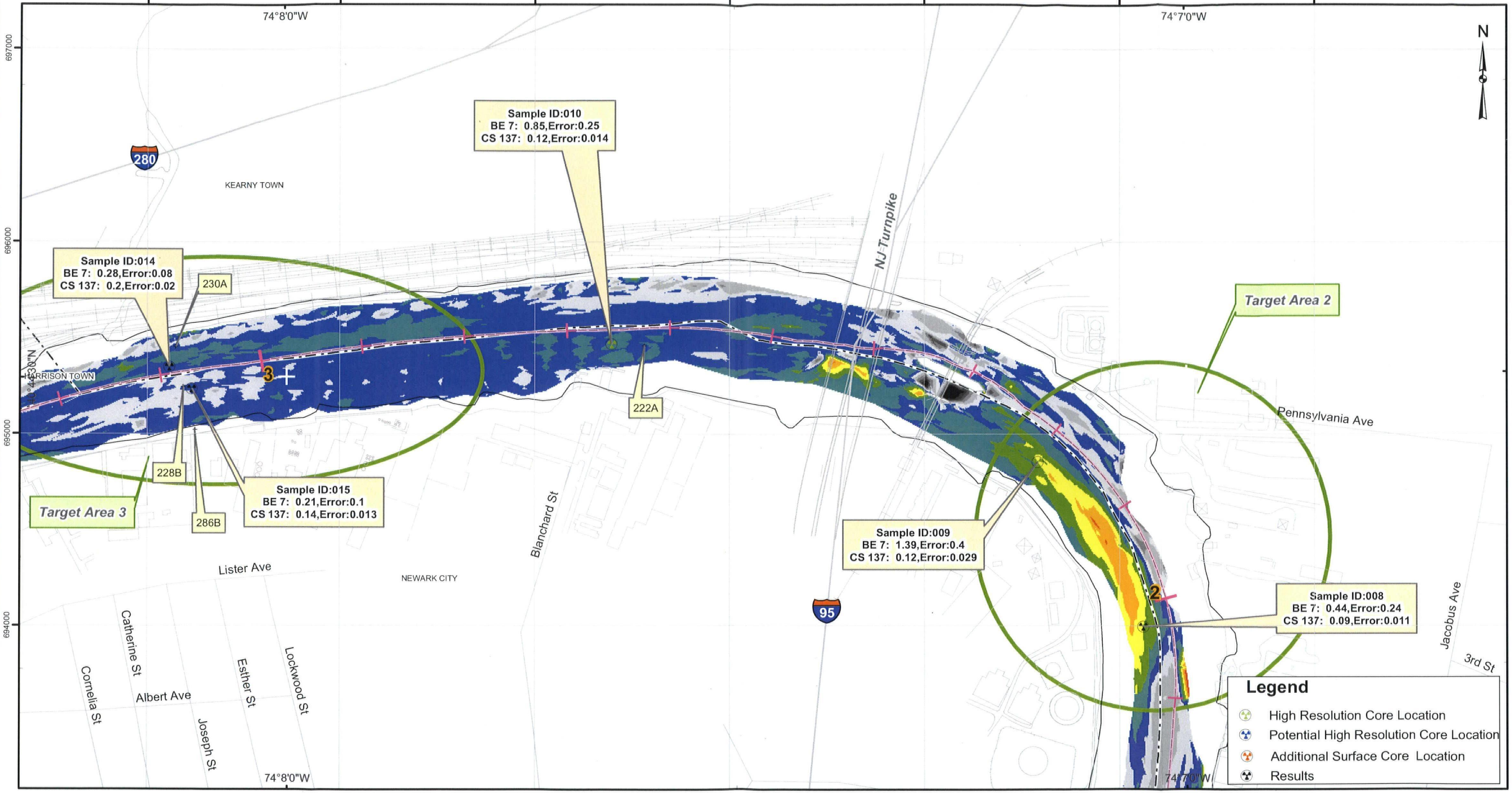
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 1 to 2

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\Mile_1_2_Portrait.mxd)
11/29/2005 -- 2:48:07 PM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data
River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet Radiological results in pCi/gt

0 250 500 1,000

1 " equals 500 '

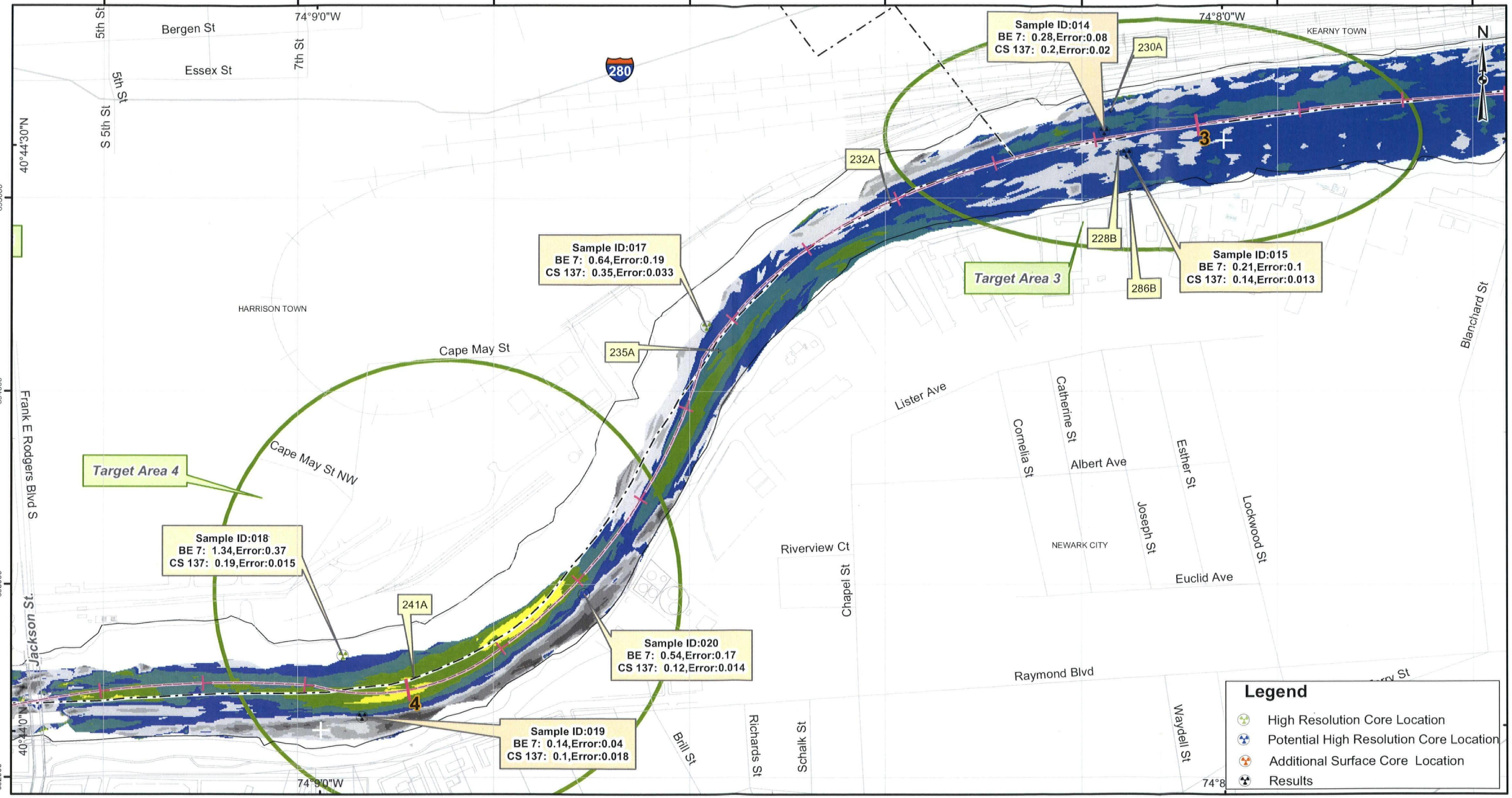
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 2 to 3

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\7_Landscape_Maps.mxd)
11/30/2005 -- 9:00:58 AM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\7_Landscape_Maps.mxd)
11/30/2005 -- 9:00:58 AM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data
River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet Radiological results in pCi/gt

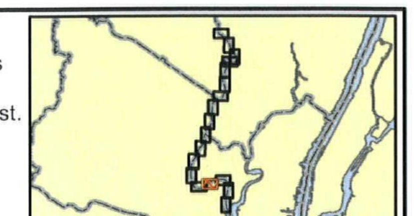
0 250 500 1,000

1 " equals 500 '

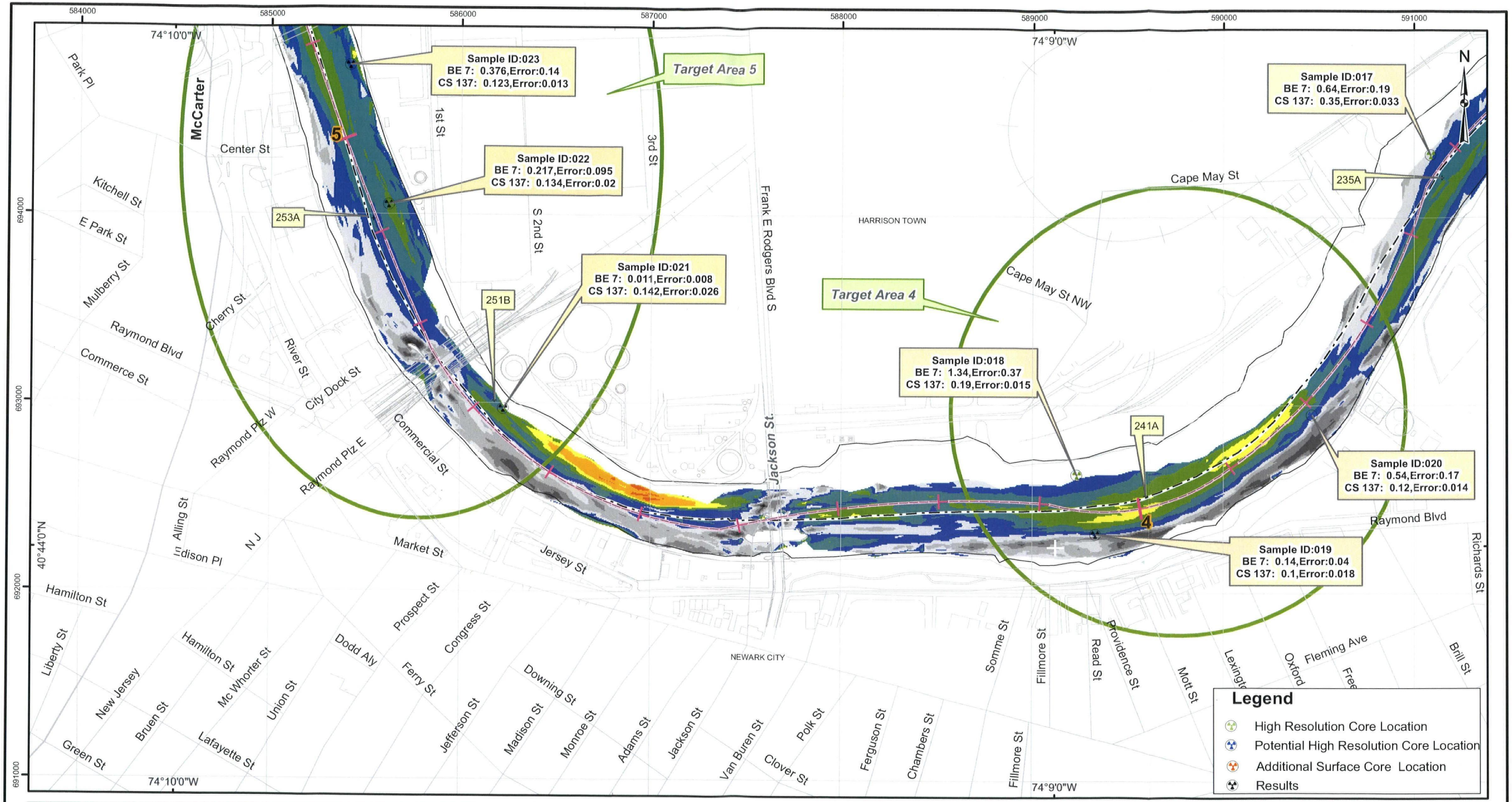
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 3 to 4



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\7_Landscape_Maps.mxd)
11/30/2005 -- 9:00:58 AM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data
River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

Radiological results in pCi/gt

0 250 500 1,000

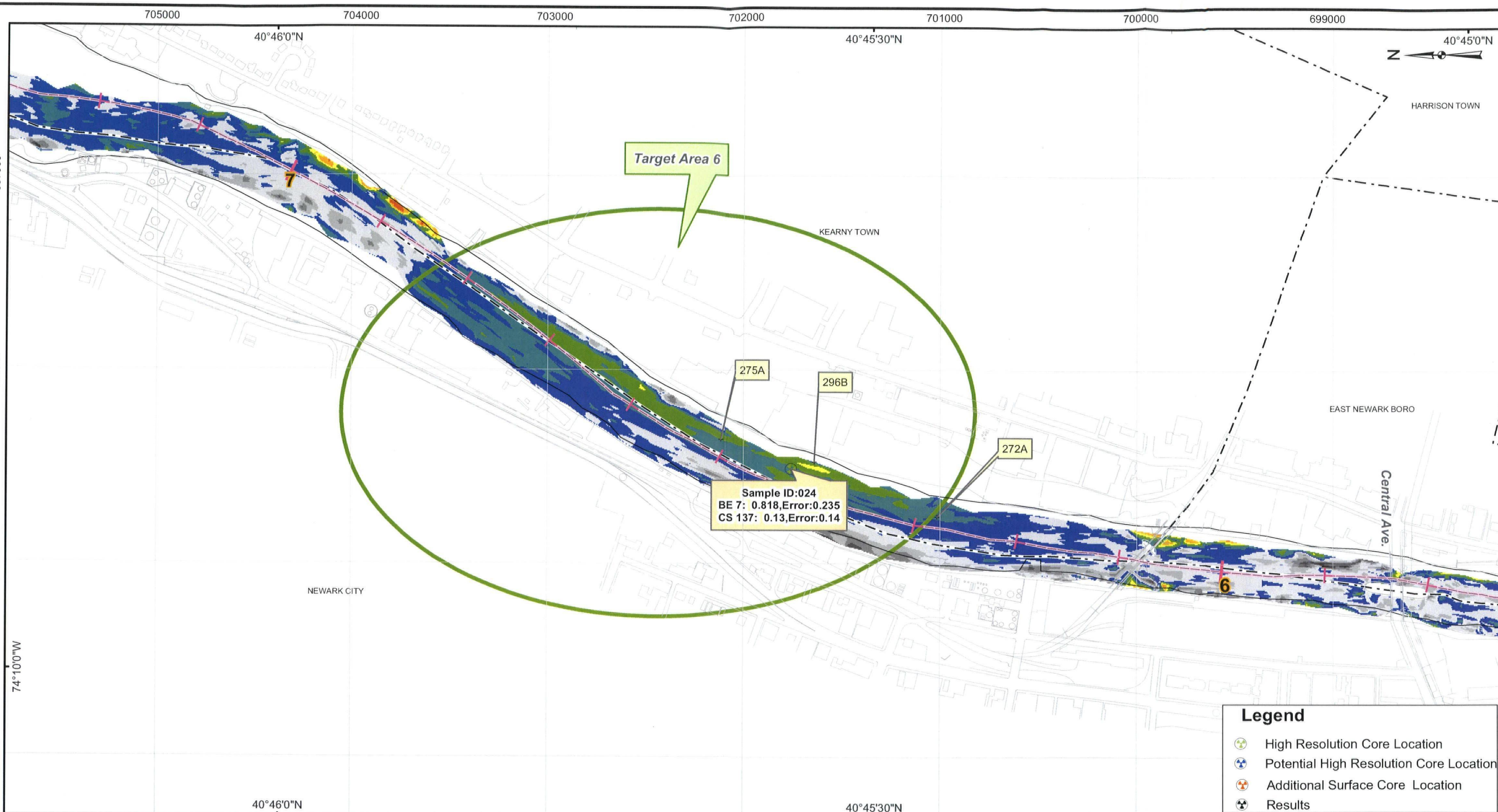
1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 4 to 5



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

\+ BBL Data

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet Radiological results in pCi/gt

0 250 500 1,000

1 " equals 500 '

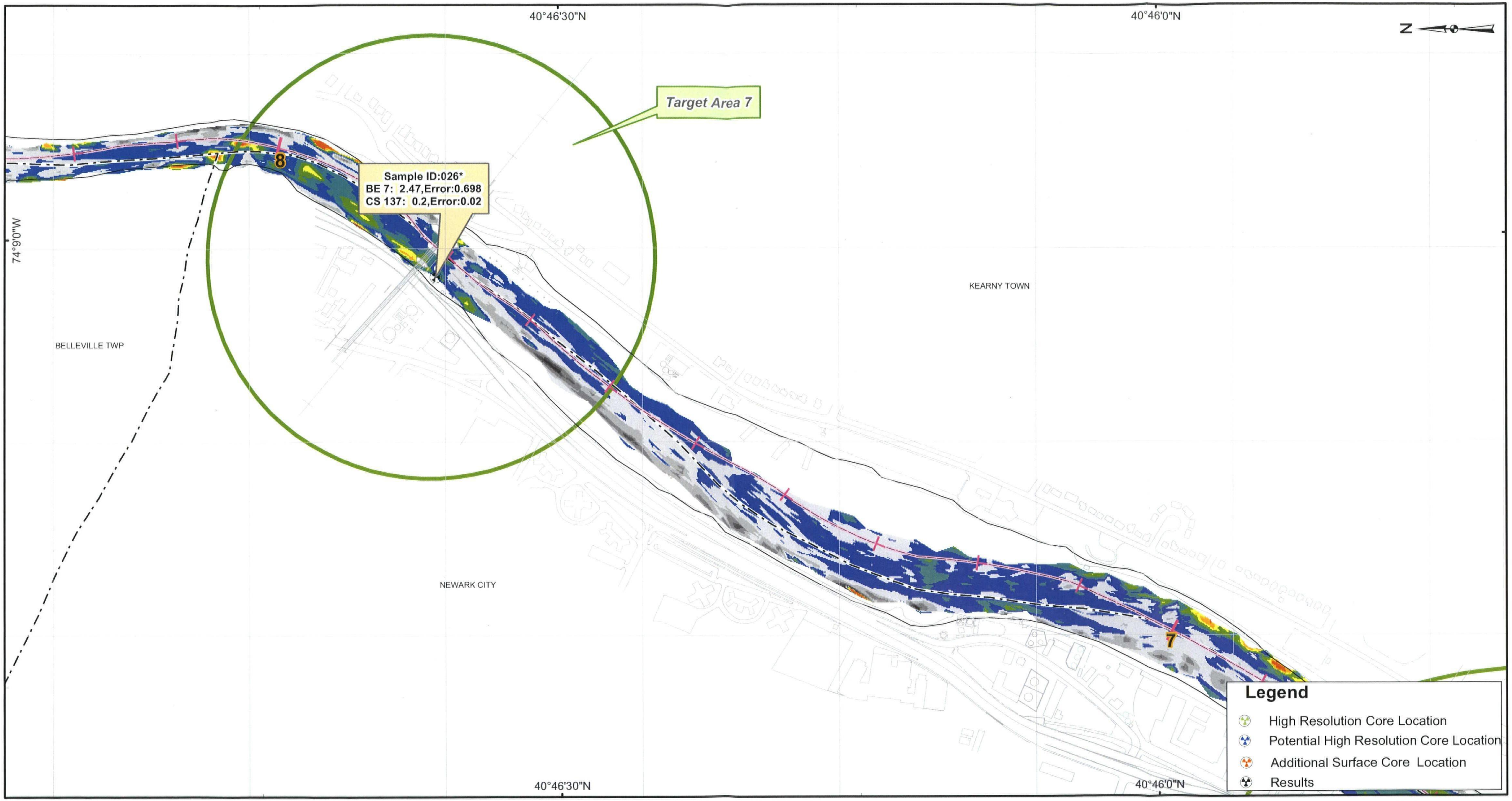
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 6 to 7

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\Mile_6_7_Portrait.mxd)
11/30/2005 -- 8:40:42 AM



Lower Passaic River Restoration Project New Jersey

Sediment Samples and Radiological Results

US Army Corps of Engineers

MALCOLM PIRNIE

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet Radiological results in pCi/gt

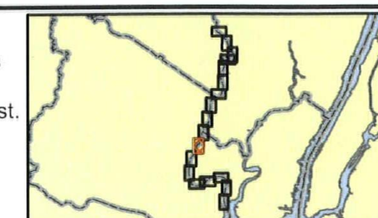
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 7 to 8

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\Mile_7_8_Portrait.mxd)
11/29/2005 -- 5:54:54 PM

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\Mile_9_10_Portrait.mxd)
11/29/2005 -- 5:55:01 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data
River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet Radiological results in pCi/gt

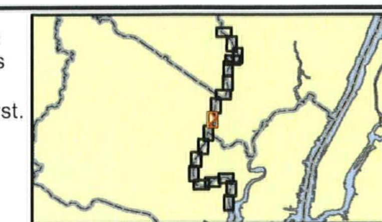
0 250 500 1,000

1 " equals 500 '

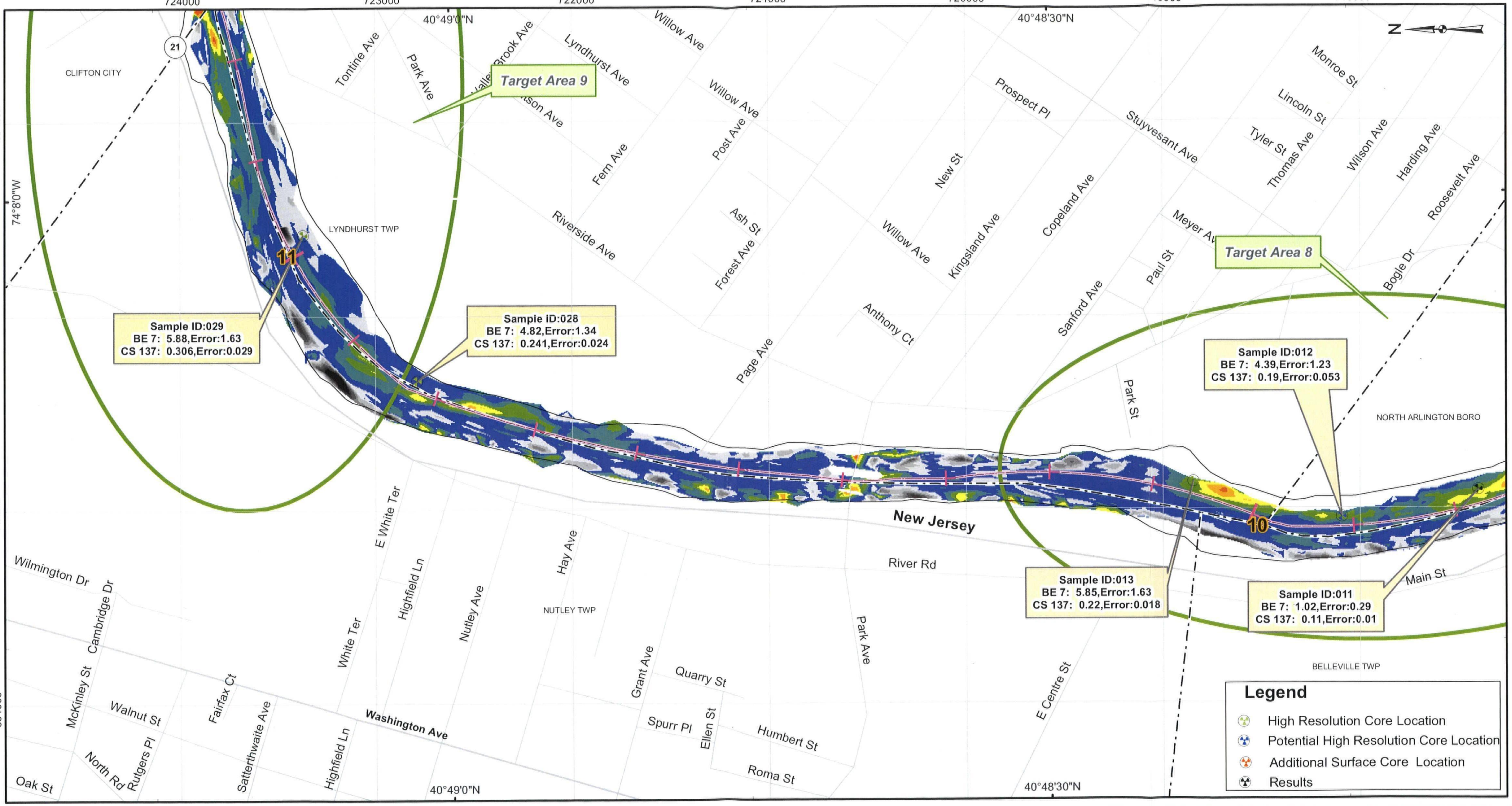
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 9 to 10



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project
New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data
River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet   Radiological results in pCi/gt

0 250 500 1,000

1 " equals 500 '

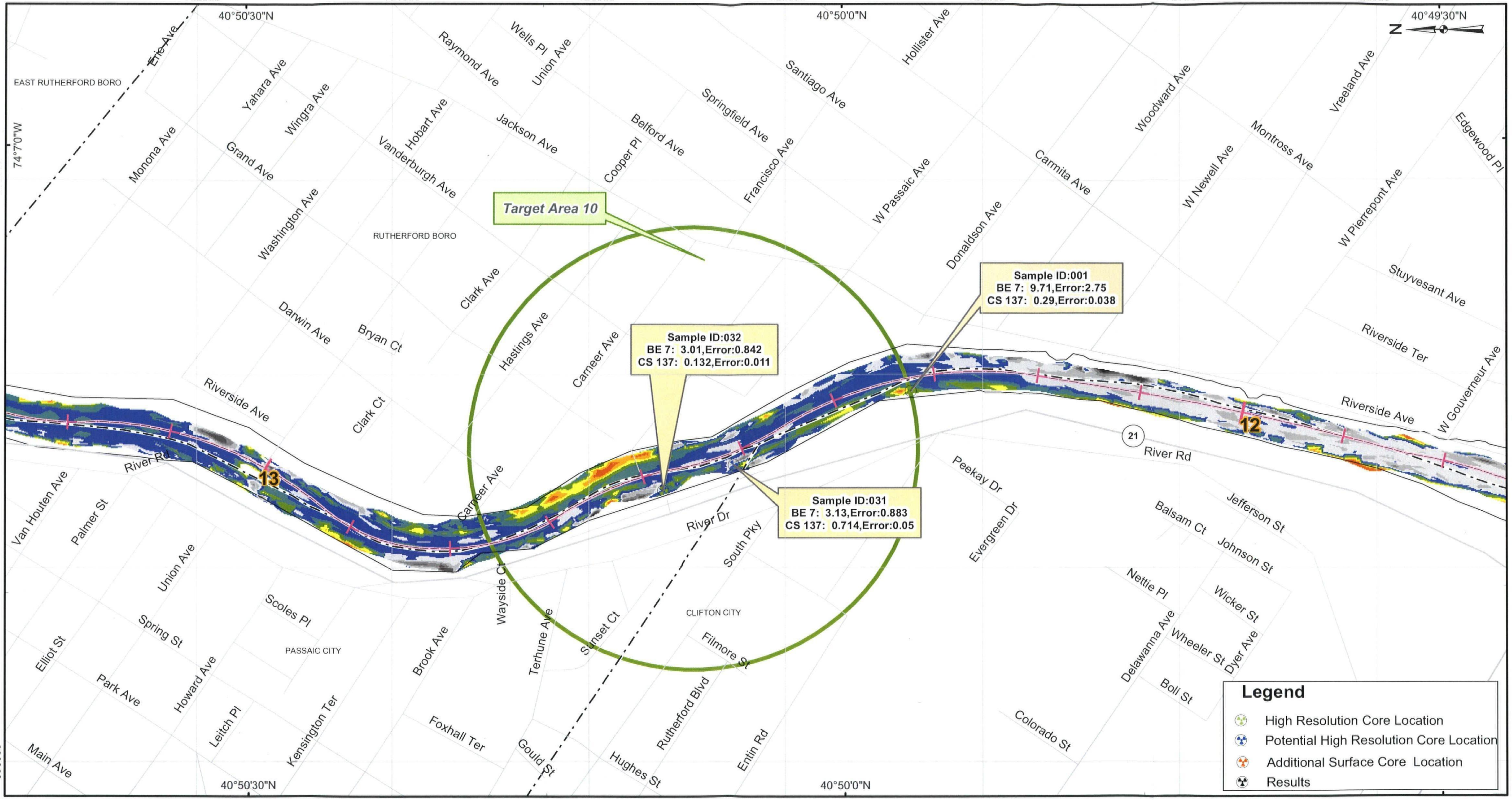
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 10 to 11

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Portrait_Maps\Mile_10_11_Portrait.mxd)
9/28/2005 -- 10:35:54 AM



US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1	+ BBL Data
-5 to -4	1 to 2	River Mile Post
-4 to -3	2 to 3	
-3 to -2	3 to 4	
-2 to -1	4 to 5	
-1 to 0	> 5	

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet Radiological results in pCi/gt

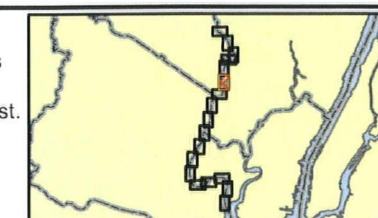
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 12 to 13

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\Mile_12_13_Portrait.mxd)
11/29/2005 -- 3:49:08 PM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River Restoration Project
New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data

River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet, Radiological results in pCi/gt

0 250 500 1,000

1 " equals 500 '

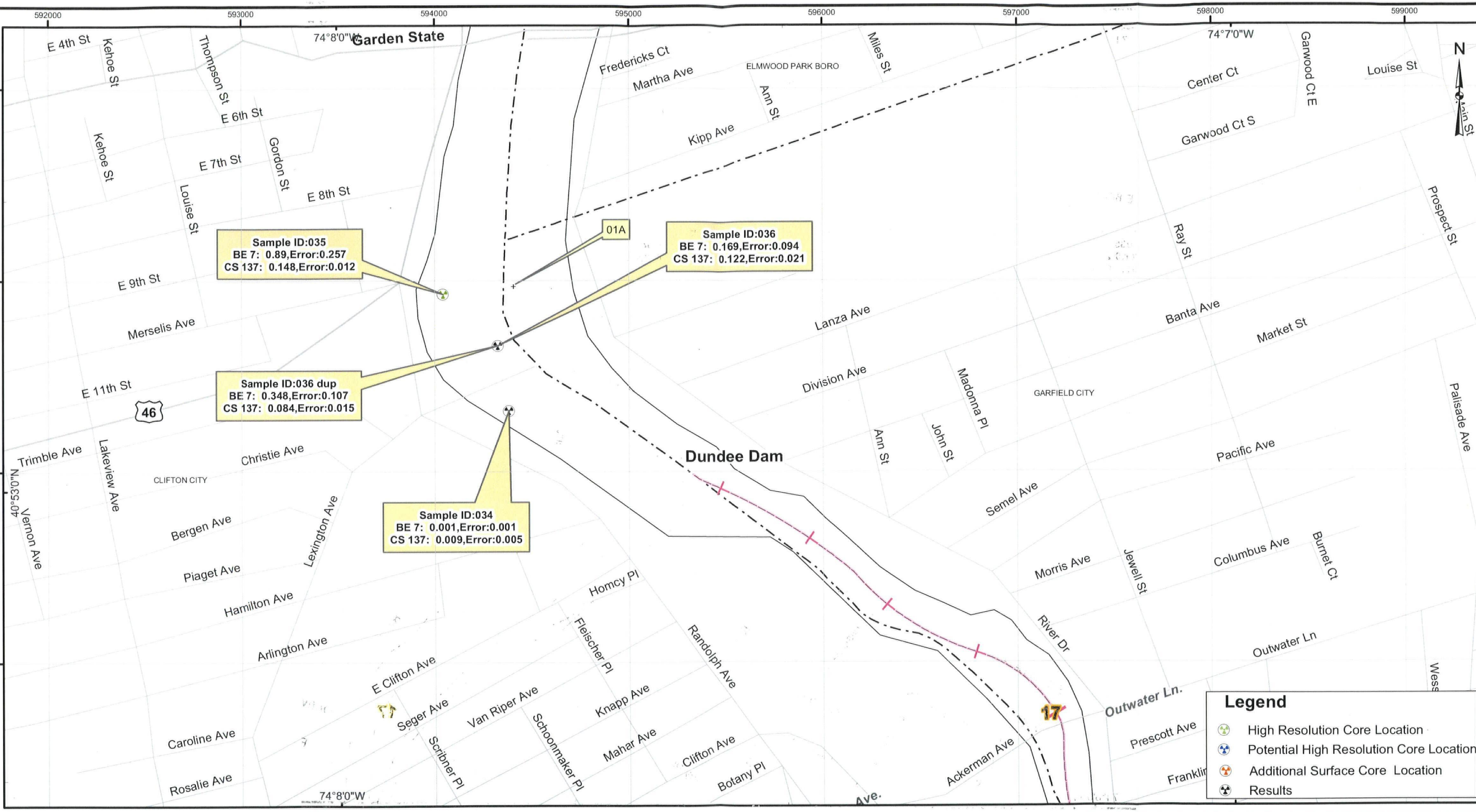
A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Mile 13 to 14

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\Mile_13_14_Portrait.mxd)
11/29/2005 -- 5:43:28 PM



Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Individual_Maps\7_Landscape_Maps.mxd)
11/30/2005 -- 9:00:58 AM

US Army Corps of Engineers

MALCOLM PIRNIE

Lower Passaic River
Restoration Project
New Jersey

Sediment Samples and Radiological Results

Legend

Sedimentation Rate
Inches per Year

< -5	0 to 1
-5 to -4	1 to 2
-4 to -3	2 to 3
-3 to -2	3 to 4
-2 to -1	4 to 5
-1 to 0	> 5

+ BBL Data
River Mile Post

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet, Radiological results in pCi/g

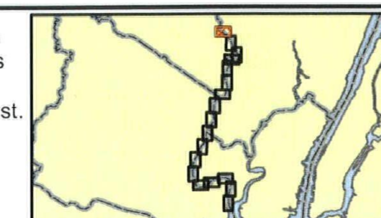
0 250 500 1,000

1 " equals 500 '

A Triangulated Irregular Network (TIN) was derived from the survey points using ESRI's 3-D Analyst in ArcGIS. Contours were interpolated from the TIN, also in 3-D Analyst.

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)



Mile 17 to Dundee Dam